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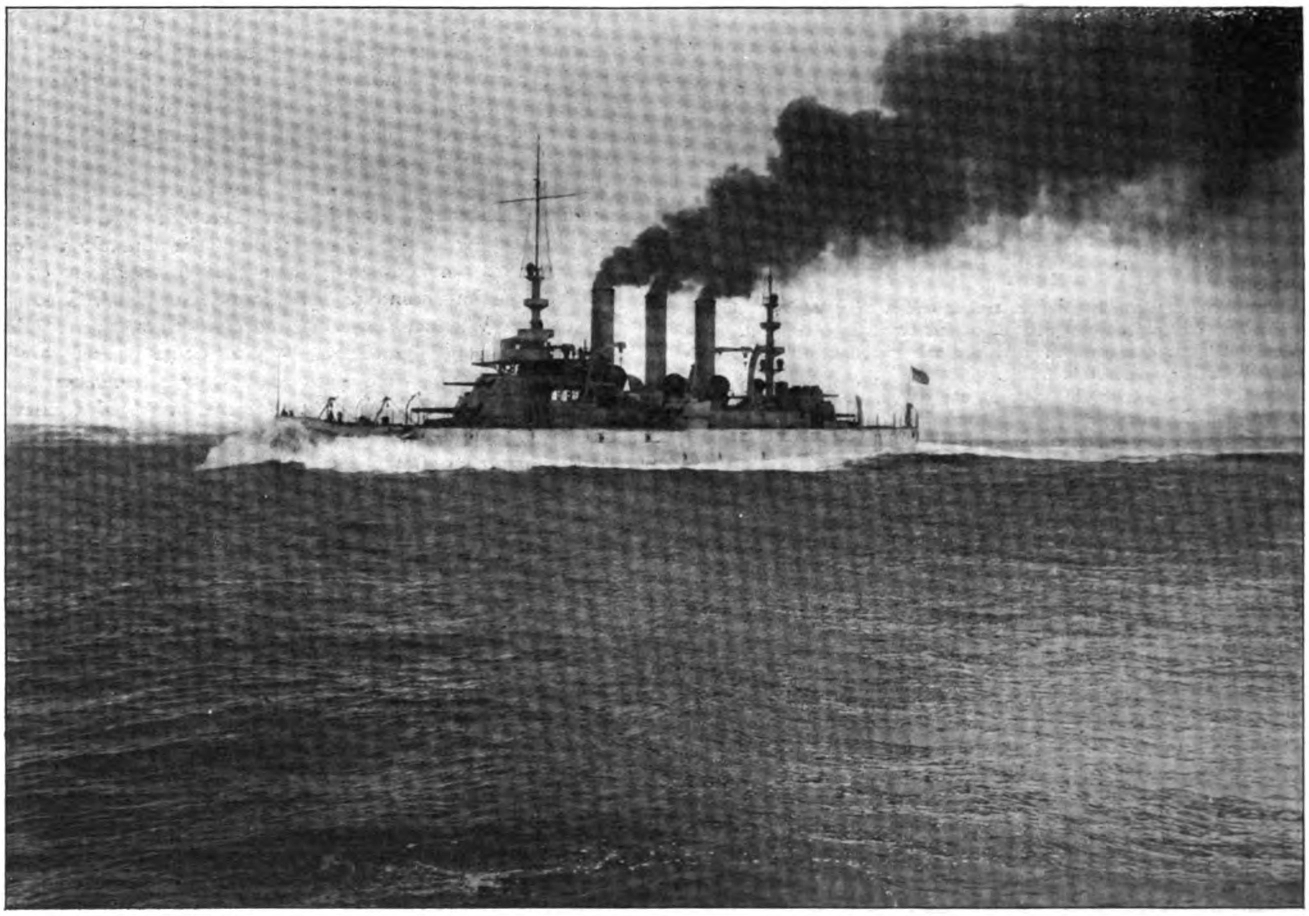
OFFICIAL TRIAL BATTLESHIP NEW JERSEY.

The battleship New Jersey, built by the Fore River Ship Building Co., Quincy, Mass., has just completed an excellent official trial. The results are the best so far upon any of the Virginia class of 19-knot battleships. The trial board complimented the builders upon the condition of the vessel as to completeness, cleanliness and order and have recommended the preliminary acceptance of the ship without further inspection.



THE BATTLESHIP NEW JERSEY ON HER OFFICIAL TRIAL MAKING 19.48 KNOTS. *Built by Fore River Ship Building Co., Quincy, Mass.*

After two days in the dry dock at the Boston navy yard, where the vessel was painted with McInnes paint, the New Jersey proceeded to Rockland, where 14 runs were made over the measured mile for the standardization of the screws. The mean of the five highest runs was 19.02 knots and the trial was so regularly conducted that the board was able to promptly determine that 124.5 revolutions of the screws would be necessary for the contract speed of 19 knots. The fastest mile was run at the rate of 19.48 per hour. On the next day the New Jersey made a four-hour endurance run in the open sea and showed an average mean revolution of the screws of 126.297, corresponding to a speed of 19.18. The maximum speed made for any fifteen minute interval of the run was 19.278 knots. The average H. P. developed by the main engines was 22,805 and the coal used showed a consumption of 2.2 lbs. per total I. H. P. per hour. The four-hour endurance run was followed by the usual maneuvering and reversing tests, all of which were successfully passed. The trial was most satisfactory to all concerned and there was no evidence anywhere in the ship of undue forcing of the engines, boilers, or auxiliaries. The sister ships of the New Jersey already tried, Rhode Island and Virginia, attained the speed of 19.01 knots on their four-hour trials.

The New Jersey has a 14,948-ton trial displacement.

SCIENTIFIC LAKE NAVIGATION.

By Clarence E. Long.

PART II.

The unit is the degree (°), which is 1-360 part, or 1°, of the circumference of any circle.

Plane Surface.—A surface that does not change its direction, as the surface of a slate, the lake on a calm day, etc., is a plane surface.

A circle is a plane figure whose boundary is at all points equally distant from the center, as in Fig. 1.

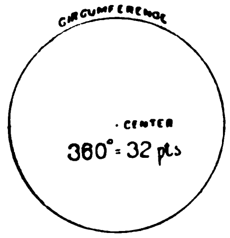


FIG. 1.

The circumference of a circle is the line that bounds it, or the curved line that forms the boundary of a circle is called the *circumference;* Fig. 1.

An arc is any part of a circumference as A B in Fig. 2. A D in Fig. 4 is an arc of 30°; D E is an arc of 60°; A E is an arc of 90°, and A B is an arc of 180°.

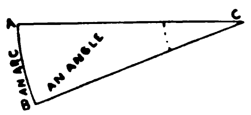


FIG. 2.

An angle is the difference in the direction of two lines proceeding from a common point called the vertex; thus A C B is an angle, and C is the vertex (center), Fig. 2. A C D Fig. 4, is an angle of 30°; D C E is an angle of 60°; E C B is an angle of 90°, or a right angle.

When the ends of two straight lines running in different directions meet, they form an angle. It is the difference in the direction of two straight lines that forms the angle, therefore, their length is not considered.

Angles are measured by degrees and fractions of a degree. Angles can also be measured by compass points and fractions of a point. The ordinary compass card can be used for this purpose, and its use is explained farther on in this lesson.

An angle is named by the letter at the vertex, or by the three letters with the letter at the vertex in the middle. Thus, in Fig. 2, we say the angle C, or the angle ACB or BCA. Remember this.

The diameter of a circle is the line passing through its center, and terminated at both ends by the circumference, as in Fig. 3. A B in Fig. 4, is the *diameter* of that circle. The diameter divides the circle into two semi-circles; or the diameter is any straight line drawn from one point of the circumference to another and passing through the center.

Radius is the straight line distance from the center of a circle to any point of the circumference; or it is any straight line drawn from the center to the circumference.

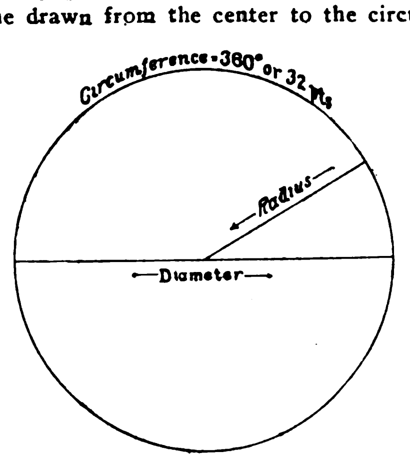


FIG. 3.

The radius of a sphere is half a diameter, or it is the distance from the center to any point of the (curved) surface. It is also called a semi-diameter. See Fig. 3. C A; C D; C E; and C B, Fig. 4, are radii of that circle. Radii is the plural of radius.

A sphere is a solid, every point of whose surface is equally distant from a point within, called its center.

A semi-circle is ½ of a circumference, or 180°; that half of a circle bounded by its diameter and half of its circumference is a semi-circle, or a semi-circumference. A graduated semi-circle is an instrument for measuring angles, also called a protractor.

A quadrant is ¼ of a circumference, or 90°.

A sextant is 1-6 of a circumference, or 60°.

A sign is 1-12 of a circumference, or 30°.

In astronomical calculations 30° are called a *Sign*, and there are therefore 12 signs in a circle. A Sign is the twelfth part of the ecliptic or zodiac. The Signs are reckoned from the point of intersection of the ecliptic and equator at the vernal equinox, and take their names from the constellations of the heavens, such as Aries, Taurus, etc., all of which is explained in its proper place.

A degree is one of the 360 equal parts into which the circumference of a circle is supposed to be divided; thus Fig. 4 shows the manner in which the circumference is divided into degrees, as do also the various compass diagrams published. The student should study these diagrams over very carefully.

A right angle is formed by drawing one line perpendicular to another. The lines A C E and E C B, Fig. 4, are *right angles.* The lines forming the directions North and East on the compass, make a right angle, or 90° = 8 points of the compass. The lines N and W, S and E, and S and W, each together, form a right angle. Four right angles, or 4 quadrants = 360°, or 32 points = 1 O, or circumference. Two right angles, or 2 quadrants (90°, or 8 points) = 180°, or a semi-circle, or ½ of a circumference = 16 points.

The measure of an angle is the arc of the circle included between its sides, thus the arc A B, Fig. 2 is the arc of the angle formed by the lines C A and C B. The measure of the angle is the arc of the circle included between the lines C A and C B. In Fig. 4, the arc A D (30°) is the measure of the angle A C D; D E (60°) is the measure of the angle D C E, etc.

Note.—Some people imagine that the number of degrees contained in any circle depends upon the size of the circle, that is, the larger the circle, the more degrees it will contain. This is absurd. Every circle is divided equally into 360 parts called degrees, and 32 equal parts, called points, no matter what size the circle may be. The space between the degree divisions at the margin, or circumference, of the circle, will, of course, vary in width, but this has nothing whatever to do with the number of degrees in which the circle is divided. For a good illustration of this see Fig. 4. The arc D to E is 60°, so is D1 to E1 60°; D2 to E2 60°; D2 to E3 60°. The arc D3 to E3 is just one-half the length of the arc D to E, though each contains precisely the same number of degrees. It is the two lines subtended that form the angle, and it makes no difference how far these lines are prolonged, the angle remains the same; the length of the arc increases with an increase of radius, but its division is always on one and the same basis.

Another very good illustration of this is the various sizes of compass cards used for steering vessels. The compass that is, say 15 inches in diameter, has its card divided into the same number of points and quarter points as the compass with a card 3, 4 or 5 inches in diameter. Some vessels have three and four compasses on board, and all of them may vary in size, and yet they are practically all used for the same purpose. Here is another illustration: Are not the dials, or faces, of the vest pocket watch, the house clock and the large tower clock, divided into the same number of hours? Their hands vary in length and they sweep greater arcs, but they all pass over the same number of divisions in the same period of time.

Note.—The first thing that will bother the student is how to measure an angle, that is, how is one to know the number of degrees that any arc should contain after any two lines have been drawn from a central point, as in Fig. 2. This is performed in various ways, the simplest method being the employment of a semi-circle, or protractor, a mathematical instrument for laying down and measuring angles on paper, etc., used in drawing or plotting. The circumference of a protractor is graduated in several ways, but is usually marked from 0° to 180°, starting from one extremity of its diameter around to its other extremity. Just inside of this outer circle is another circle with the same graduations, marked the other way, that is, 0° coincides with the 180th degree division, and the 180° division coincides (in line with) with the 0° division. This is done in order to have a starting point in any of the four quadrants of the circle, namely: the upper right hand portion of a circle is called the 1st quadrant; the upper left hand portion is the 4th quadrant; the lower right hand portion is the 2nd quadrant; the lower left hand portion is the 3d quadrant. Again, from N to E on the face of the compass is the 1st, or NE quadrant; from S to E, the 2d, or SE quadrant; from S to W, the 3rd, or SW quadrant; from N to W, the 4th, or NW quadrant.

To Measure an Angle with a Protractor.—The center of the Protractor, on its diameter side, is notched, and represents the vertex, or center of the angle. Place this notch directly over the vertex of the angle to be measured (the two lines radiating from it). Place the straight side (diameter) of the protractor along one of the lines, or sides of the angle. Then read off on the circumference of the proctractor, that is, the arc of the circle included between its sides is the measure of that angle. It is not necessary to even do this. Place the center mark over the vertex and then count off the degrees on the circumference of the proctractor between the lines, or where these coincide with the outer edge of the protractor. The number of degrees on the arc is the measure of the angle.

Protrafors are made in various sizes. 2, 3, 4, 5, 6, etc., inches in radius. It will bother the novice to measure an angle whose sides, or radii, are not as long as the radius of the protractor, as in Fig. 2. To do this, merely prolong the lines C A and C B, a little longer than those of the protractor, and then measure the angle.

A line drawn perpendicular to another line forms a right angle, 90°, or 8 points, as E C A and E C B in Fig. 5. A line drawn half way between E and B equals 45°, half way between this is 22½°, and half way between this equals 11¼°, etc. Fig. 4, or any compass card could be employed to measure angles in the same manner as explained for using the protractor. The protractor and how to use it is fully explained in another lesson.

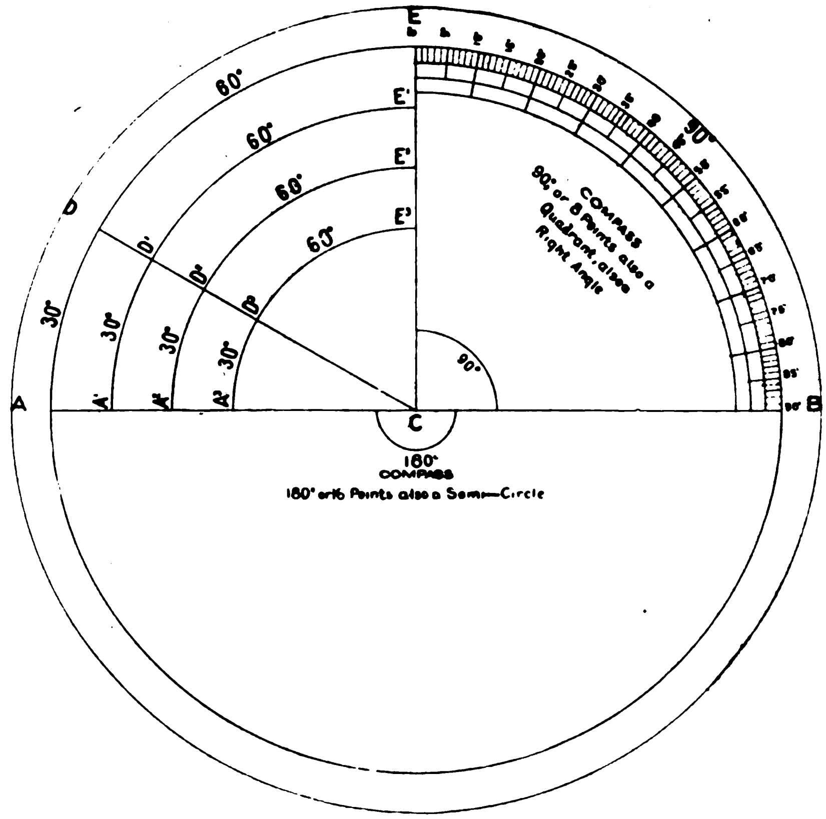


FIG. 4.

A straight line is a line that does not change its direction. It is the shortest distance between two points on a plane surface.

The shortest distance between any two points on the *earth's* surface (spherical) is the arc of the great circle that intercepts them.

To follow the Great Circle track, or course, vessels have to alter their course at stated intervals—how much depending upon the distance between the points sailed for, and on which portion of the globe the places are located. The higher the latitudes the greater change in the course, and the lower the latitudes the less alteration of the ship's head in order to keep to the great circle. In equatorial regions there is but little difference between the great circle and the straight line course, known as rhumb line. Long distances, like crossing the Pacific from San Francisco to Yokohama, Japan, would save a ship several hundred miles run by following the great circle instead of the constant straight line course. It is possible to make this run by steering one course—the straight line course, provided wind and current did not force the vessel out of her course. To keep the straight line course the ship would have to run a couple of hundred miles farther than if she followed the great circle course. Following the straight line course (this is only apparent, for while the course appears straight on the chart, on the earth's surface it is curved—a species of spiral, or winding) the ship would make a wide detour to the south'ard. In north latitude it is always to the south'ard, in south latitude to the north'ard; that is, the ship's head makes a detour toward the equatorial regions, and the ship is never heading for the point of destination until she brings it in sight. On the other hand, the ship on the great circle track has her head pointed for the place of destination from first to last; but, in order to do this the direction of the ship's head must be changed. The great circle track always lies on the polar side of the rhumb line.

Any small section of the earth's surface, is, for all practical purposes, a plane, the curvature being imperceptible; that is, it is disregarded, and of no consequence. Therefore, there is practically no difference between the great circle and the straight line. On the Great Lakes the greatest difference between the great circle and the straight line, or rhumb tracks, for the longest possible routes, is a little more than a half mile. All these matters are explained in detail in another lesson. While these notes do not really belong to the lessons under discussion, they are added for the purpose of assisting the student in acquiring a correct knowledge of the definitions stated; hence, they should be studied very carefully.

A curved line changes its direction at every point; hence, to follow it, the direction must be changed accordingly.

Any small arc of a great circle (the earth's circumference is a great circle) is practically a straight line. A great circle then, is practically a series of straight lines.

Parallel lines have the same direction; and being in the same plane and equally distant from each other, they can never meet.

A horizontal line is a line parallel either to the horizon or water level; on a level, as A B in Fig. 5.

An oblique line is a slanting line that, meeting or tending to meet another line, makes oblique angles with it as D C in Fig. 5.

The vertex of an angle is the point in which the sides of the angle meet; as C in Fig. 5.

The lines, or sides, A C and D C in Fig. 4 form the angle of 30°, or a sign, the point C being the *vertex of the angle*. D C and E C in the same figure, are the sides of the angle 60°, or a sextant, the point C being the vertex.

A perpendicular line is a line exactly upright (vertical) as C E Fig. 5, or a line falling at right angles on another line or surface, making equal angles with it on each side; (a plumb line); a line at right angles to the base.

Note.—A *perpendicular line* is not necessarily a *vertical line.* When, for example, a line is at right angles to another, it is said to be perpendicular to it, no matter what its direction may be. Perpendicular, therefore, is a relative word, and ought not to be used without reference to something else *Vertical* is an absolute word, and means the direction of the plumb line. Thus, in Fig. 5, if a line were drawn at right angles to C D, either above or below it, would be a perpendicular line, since it is at right angles to the base line C D. Take the directions on the compass, for example: A line perpendicular to NE and SW could be either NW or SE, because these directions are exactly at right angles therewith.

A perpendicular to a horizontal line is called a vertical line.

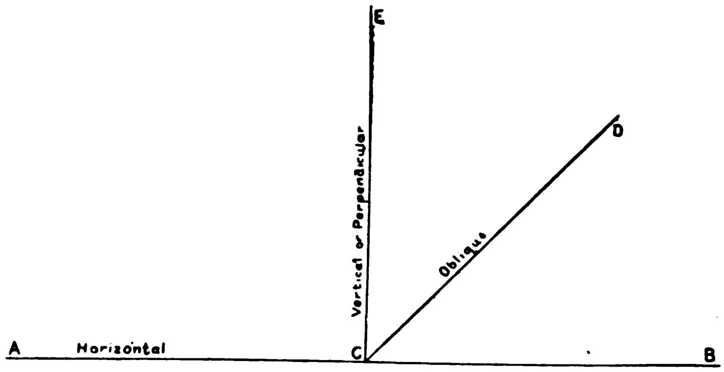


FIG. 5.

A plane figure is a portion of a plane surface bounded by straight or curved lines.

A line is that which has *length* only.

A point is that which has *position* only.

Angular point—the vertex, that is, the meeting point of any two straight lines forming an angle.

A point *of the compass* is one of the 32 equidistant directions, or division-points marked on the card of the mariner's compass; or a corresponding point in the horizon, or vertical plane, passing through the horizon and one such points. The corresponding points by which the circle is supposed to be divided, of which the four marking the directions of East, West, North and South are called *cardinal points;* and the rest are named from these directions, as NE (north-east) takes its name from the two cardinal points between which it is equidistant. NE, SW, SE and NW are called *inter-cardinal points* for this reason. The point lying midway between N and NE takes its name from the nearest cardinal point (north) and the adjacent inter-cardinal point (NE), hence its name, NNE (north-northeast), etc.

A vertical plane is supposed to be a flat surface without thickness. Perhaps the nearest resemblance to such an ideal condition will be found in a sheet of tissue paper, imagined to be standing on its edge in a perfect upright, or vertical position—the upper edge of the sheet pointing to the zenith (directly overhead) and the lower edge of the sheet towards the nadir (opposite the zenith), that is, the sheet is supposed to be in the same line with the zenith, the center of the earth and nadir. To make this the more comprehensive, imagine the plumb line prolonged until it reached the apparent sky (overhead) and then downward through the center of the earth until it came through diametrically on the opposite side of the earth (antipode). Now, imagine this sheet of paper held in this position to coincide with any point of the compass, as north and south, for instance, then imagine the sheet of tissue prolonged in a horizontal line until it met the apparent horizon, would give the horizon directions of the compass. The common clock pendulum, when in motion, moves to and fro in the *vertical plane.* The card of the mariner's compass, attached to magnetized needles, and when the whole is poised at its center of gravity and free to turn on this pivot, moves in the *horizontal plane.* The vertical and horizontal planes are at right angles, or 90°, from each other.

RECAPITULATION.

The semi-circumference is one-half of any article, and therefore equals 180° or 16 points; ½ of 360° = 180°; ½ of 32 points = 16 points.

A quadrant is ¼ of any circle or circumference, and equals 90° or 8 compass points; ¼ of 360° = 90°; ¼ of 32 points = 8 points.

A sextant is 1-6 of any circle or circumference, and equals 60° or about 5⅜ points; 1-6 of 360° = 60°; 1-6 of 32 = about 5⅜ points.

The greatest distance across any circle is called its *diameter.* The distance round it is called its *circumference,* and any part of the circumference is called an *arc.*

A straight line from north to south on any size compass card is the diameter of that card or circle, or for that matter, from any point across the card in a reverse direction, is a diameter—so that it cuts the circumference in two points.

The distance from north by way of east, south, west and back to north on any compass card or circle, represents a circumference; or the distance round from any point or degree back to the point or degree of starting, is a circumference.

From north to south by way of either east or west, is a semi-circumference, or a semi-circle; also from east to west by way of either north or south, equals a semi-circumference; hence, by starting from any point or degree on the compass card, and by going half the distance round the card, or to *reverse* the direction or point started with or from, equals a semi-circle, or an arc of 180° or 16 compass points, no matter what the size of the circle or card might be.

From north to east is an *arc* of 90° or 8 points; from south to S by E an arc of 11° 15′ or 1 point, etc.

The radius of any circle is one-half its diameter, or the radius is simply one-half the diameter; hence, from the center of the compass card out in any direction to its edge or circumference, is equal to the radius of that circle; or any straight line from the center to the circumference is radius.

An *angle* is the difference in the direction of two lines starting from the same point or place. This point or place from which the lines proceed is called the *vertex* of the angle; the lines themselves are the *sides* of the angle. A straight line from the center of any compass card out to, or towards, north, and from the center out to, or towards, NE on the circumference, makes an angle of 45° or 4 points with each other. From the center to north and from the center to N by E, the two lines or sides make an angle of 11° 15′ or 1 point, etc. The angle of any two lines or directions, from the center of the card outward may be measured at the circumference by the arc of the circle that is included between, or joins the two lines or directions, in question.

The arcs of circles are used to measure angles. An angle having its vertex at the center of a circle (and all problems of the compass have) is measured by the arc included between its sides. To measure angles, the circumference is divided into 360 equal parts, called degrees. Each degree is divided into 60 equal parts, called minutes; each minute into 60 equal parts, called seconds. Degrees,

minutes and seconds are marked thus, °, ′, ″; 18°, 24′, 30″ are read 18 degrees, 24 minutes and 30 seconds. From this it will be readily seen that a right angle is measured by 90°; half a right angle, by 45°; two right angles, by 180°; four right angles, by 360°.

The measurement of an angle depends on the arc of any circle included between its sides, or that much of any circle that two lines forming the angle will measure in degrees or points. It is neither the length of the lines forming the angle nor the length of the arc that determines the number of degrees in an angle, but the number of degrees that the arc measures or contains between the two angle lines for a given radius; therefore it depends on the length of the radius of the protractor or compass card used; hence, for this reason, any size protractor or compass card may be used to measure angles, since every circumference is divided into an equal number of parts, no matter how large or how small it may be. The only difference in the size of the circle is the width between the circumference divisions of the degree; the smaller the circle the smaller the space between the degrees, and the larger the circle the greater this space, but this has nothing to do with it. Fig. 4 is a good illustration of this; take the angle of 60° with its various arcs.

The center of a circle being placed at the vertex of any angle, the angle is measured by the arc included between the lines which include the angle. As arcs are measurements of angles, the table for angular measure is the same as the table for circular measure. The point or place from where the angle lines start or begin, represents always the center of a circle. For this reason in measuring an angle with a protractor or compass card its center is placed directly over this point. The number of units in an angle is equal to the number of units of any arc in that angle; therefore, the arc may be used as the measure of the angle. This theorem is usually expressed thus: "an angle at the center is measured by the intercepted arc." The statement is, however, rather conventional, "measured by" meaning "having the same numerical measure." Both angle and arc have the same numerical measure; hence, the arc may be assumed as the measure of the angle. It would seem more natural to measure an angle by a quantity of the same kind, and for this purpose a right angle would naturally be taken as the unit of measure. It has been found more convenient, however, to use the arc of a circle as the measure of an angle, and for this purpose the circumference has been divided into degrees, minutes and seconds, as before explained.

Since it is the radius of a circle that describes a circle, the space between the degree divisions of the arc, must necessarily depend upon the length of the radius. The longer the radius the greater the space between the degrees, but the devision of the units is determined from the same basis in every case, and consequently does not depend on the size of the radius, or the size of the arc; there being the same number of degrees in any arc that is and can be drawn between the same two lines forming the angle.

Remember, that in the same circle, equal angles at the center intercept equal arcs on the circumference; or conversely, in the same circle, equal arcs subtend equal angles at the center.

EXAMPLES.

How many minutes (′) in 12°? Ans. 720′.
How many seconds (″) in 12°? Ans. 43,200″.
How many thirds (‴) in 12°? Ans. 2,592,000‴.
How many ′ in 9°? Ans. 540′.
How many ′ in 45°? Ans. 2,700′.
How many ′ in 18°? Ans. 1,080′.
How many ″ in 180°? Ans. 648,000″.
How many ‴ in 180°? Ans. 38,880,000‴.
How many ′ in 11° 15′? Ans. 675′.
How many ″ in 5° 37′ 30″? Ans. 20,250″.
How many thirds in 5° 37′ 30″? Ans. 1,215,000.
How many degrees in a semi-circle? Ans. 180°.
How many minutes in a semi-circle? Ans. 10,800′.
How many degrees in a quadrant? Ans. 90°.
How many minutes in a quadrant? Ans. 5,400′.
How many degrees in 6,264,000‴? Ans. 29°.
How many degrees in 162,000″? Ans. 45°.
How many ° in 2,700′? Ans. 45°.
How many ′ in 19,440,000‴? Ans. 5,400′.
How many ″ in 19,440,000‴? Ans. 324,000″.
How many ° and ′ in 19,440,000‴? Ans. 90°.
How many ° in 73′? Ans. 1° 13′.
How many ′ in 108″? Ans. 1′ 48″.
How many ″ in 134‴? Ans. 2″ 14‴.
How many ° in 114′? Ans. 1° 54′.
How many ′ in 96″? Ans. 1′ 36″.
How many ° in 120′? Ans. 2°.
How many ′ in 137″? Ans. 2′ 17″.
How many ‴ in 14° 15′? Ans. 3,078,000‴.
How many ° in 32 points? Ans. 360°.
How many ° in 16 points? Ans. 180°.
How many ° in 8 points? Ans. 90°.
How many ° in 4 points? Ans. 45°.
How many ° in 2 points? Ans. 22° 30′.
How many ° in 1 point? Ans. 11° 15′.
How many ° ½ point? Ans. 5° 37′ 30″.
How many ° ¼ point? Ans. 2° 48′ 45″.
How many ° in ¾ point? Ans. 8° 26′ 15″.
How many ° in ⅛ point? Ans. 1° 24′ 22″ 30‴.
How many ′ in 1-16 point? Ans. 42′ 11″ 15‴.
1° is a trifle less than 1-3 of a point.
How many ′ in 8 points? Ans. 5,400′.
How many ″ in 4 points? Ans. 162,000″.
How many ‴ in 4 points? Ans. 9,720,000‴.
How many points in 4,860,000‴? Ans. 2 points.
How many points in 77,760,000‴? Ans. 32 points.
How many points in 39° 22′ 30‴? Ans. 3½ points.
How many ° in 1¾ points? Ans. 19° 41′ 14″.
How many ° in 7¼ points? Ans. 81° 33′ 45″.
How many ° in ⅝ points? Ans. 7° 1′ 52″ 30‴.

Note.—Of course you will understand that a great many of the foregoing examples are of no practical benefit, but are merely given to make the pupil think, and to teach him the why and the wherefore. In practical work a quarter point is reckoned as 3°, whereas it is 2° 48′ 45″; ½-point is reckoned as 5½°, or even 6°; ¾-point as 8¼°, or even 8°, etc. Do not think because this is true that it is not necessary to work smaller than to degrees.

Note.—If you are not familiar with the method known as "boxing the compass," you need not work the following examples relating thereto, until you have learned it. Many of these examples are not practical, but they nevertheless lead to a thorough understanding of the information contained on the compass card.

EXAMPLES ON THE COMPASS.

How many ′ is it from N to NE? Ans. 2,700′.

How many ° is it from N by E ½ E to E? Ans. 73° 7′ 30″.

How many ′ is it from SE to SE by E? Ans. 675′.

How many points is it from W to WNW? Ans. 2 points.

How many ½ points is it from N ½ W to SW by W ½ W? Ans. 20 halves, or 10 points.

How many ¼ points is it from SSW to SW? Ans. 8 quarter points.

How many ⅛ points from S to S by W? Ans. 8 eighths, or 1 point.

How many ¼ points in 33° 45′, or from N to NW by N? Ans. 12 quarter points, or 3 points.

Change 275,430‴ to its highest denomination. Ans. 1°

16′ 30″ 30‴; found thus: 275,430‴ ÷ 60 = 4,590″ 30‴ ÷ 60 = 76′ 30″ 30‴, 76′, being equal to 1° 16′. Proof: 1 × 60′ = 60′ + 16′ = 76′, 76 × 60″ = 4,560″ + 30″ = 4,590″, 4,590 × 60‴ = 275,400‴ + 30‴ = 275,430‴.

How many ° in 2½ points? Ans. 28° 07′ 30″.

How many points is it from N 22½° E to N 78¾° E? Ans. 5 points.

How many points is it from S 5° 37′ 30″ W to S 56¼° E? Ans. 5½ points.

How many ° from W ¾ N to N ¾ W? Ans. 73° 07′ 30″.

Note.—Answers are given to all problems, and if there is one thing, more than another, that we wish to caution the student in, it is about this important matter. In working any of these examples the student should not be governed by, nor work to its answer, but he should work each example according to its own rule and principle, and in no way should he be guided by the answer given, other than as a proof of his work. These answers take the place of the teacher, and act as a guide and proof to the answers obtained by the student. In the schoolroom, where the text-books employed contain the answers or the key, to the problems, pupils will seek them out first and then work the example to it. This kind of knowledge is almost worthless, and no person, who has his own interests at heart, and desires to advance himself on true merits, would think of doing such a thing. This is a most important matter, and the student should bear it in mind. If you cannot work more than one example out of ten, and you work it through reasoning out its principles, you are making more real progress than he who works the ten and is controlled by their answers.

It sometimes occurs, when a puzzling example is stated, that reference to the answer will suggest thoughts that will guide in working the problem. We have endeavored to state every example as clearly as possible, so that this source of trouble should be entirely eliminated from the work. Learn the definitions, rules, principles and working processes of the various subjects treated, and you will experience no trouble whatever.

This is a good way to remember what an angle and an arc are: From north to NE is an angle of 45° or 4 points, and so is the arc of the circle included between them. From north to N by E is an angle of 1 point, or 11¼°. The student should imagine these lines drawn from the center to the circumference to meet these points. Be sure to learn these definitions thoroughly. If you learn them in the first place as they should be learned, you will save time, and be able to make more real progress than you will if you have to stop every little while and look them up.

TO ENFORCE PASSENGER LAWS.

Captain Going, of the Japanese steamship American Maru, was very recently arrested at Honolulu on complaint of the United States district attorney, charging him with violating Sections 2 and 4 of the passenger act of 1882, and was sentenced to pay a fine of $25,000, and imprisonment for six months. An appeal was taken and Capt. Going released on bonds and the vessel allowed to proceed on her voyage to San Francisco.

Section 2 had to do with the accommodations on passenger ships. It provides for the number of berths in each cabin, the air space necessary for each individual, and the division of the quarters assigned to different sexes. In the steerage of liners from the Orient, where Chinese and Japanese are carried, the law on these points is said to be seldom observed.

Section 4 provides for the amount of food to be dispensed. Each passenger is entitled by law to one and a half shares, navy rations, and offenses against this section are punishable with a fine of $500 and imprisonment for six months.

The department of commerce and labor has given notice to the collectors of the various ports that the strict observance of these provisions must be insisted upon. The arrest of other trans-Pacific captains is expected to follow soon.

NEW B. & O. PIER AT LOCUST POINT.

The work on the subconstruction of the new freight pier the Baltimore & Ohio Railroad has under construction at Locust Point is well under way and the McLean Construction Co., which has the contract, expects to finish it sometime next August. The unusually mild winter enabled the contractors to push the work quite rapidly. During the past week seventeen concerns were furnished with plans and specifications for the superstructure and invited to bid on the work, which is to be completed by May 1, 1907. This new pier will be one of the largest and most completely equipped freight piers on the Atlantic coast. It will be known as new pier No. 8 and will take the place of old piers Nos. 6, 7, 8 and 9, which will be removed.

With the steady and heavy increase of freight traffic over the entire Baltimore & Ohio system, the export and import business at Locust Point has grown to be very large and necessitates increased facilities for handling it. The enormous quantity of grain alone, which is brought there over the road and loaded upon vessels for exporting, is not generally known. With elevator capacity for about 2,250,000 bus., it has frequently occurred recently that between 2,000,000 bus. and the maximum capacity was on storage. This has been due to the very heavy movement of corn, the storage there now of this cereal being about 1,200,000 bus.

The pier now under construction is the second to be completed under the general improvement policy which the railroad company is pursuing at Locust Point. The first was pier No. 9, which was completed about a year ago and which is particularly equipped for handling immigrant business. It is one of the largest, most modern and best equipped piers in the country, and was fully described in the newspapers on different occasions.

The character of this tidewater terminal improvement will make a most creditable showing for the engineering department of the railroad, Mr. D. D. Carothers being the chief engineer, Mr. J. E. Greiner, assistant chief engineer and Mr. Wm. Graham, assistant engineer of bridges and buildings.

The magnitude of pier No. 8 can best be shown in the description. It will be two stories in height and will have a total floor space of 300,000 sq. ft. as against 150,000 sq. ft. in the old piers which it replaces. It will rest on about 10,000 piles averaging 60 ft. long. These piles are driven to solid bottom and will be cut off well below water and capped with heavy timbers upon which will be laid a floor of 8-in. lumber. On this floor concrete piers will be built under the building columns and a concrete wall on each side of the depressed tracks, as well as on each side and end of the pier. The space inside these walls will be filled with sand and the first floor will be carried on timber sleepers imbedded in this sand. The frame work of the building will be of steel, and about 2,000 tons of this material will be required. The sides and end walls will be of galvanized corrugated iron.

The second floor will be carried on heavy timber joists resting on steel girders. The flooring will consist of an underfloor of pine with a finished surface of maple, which, while expensive, has proven by experience to be in the long run the most economical for trucking floors viewed from the point of maintenance and operation.

First class composition roofing will be used. The building will be well lighted with skylights and windows of wired glass for protection from outside fires. Numerous wharf drops will be provided for convenience in getting freight out of lighters.

The building will be equipped with eight large elevators, four barrel hoists and four traveling cranes. These latter cranes are new features on freight piers. They will travel

on a single rail set in the first floor and have an overhead guide. The cranes will be able to lift heavy loads out of cars and place them on trucks or on large storage piles, and will be able to carry loads from one end of the building to the other. The elevators and cranes will be operated by electricity.

Special attention has been paid to meeting the views of the fire underwriters in the design of this pier, and the building is to be completely equipped with a system of high pressure water pipes and hose for fighting fire, and also have a fire wall across the center of the building with all openings provided with effective fire doors.

The pier will have berth space for three of the largest vessels that come to Baltimore.

NEW TYPE OF FREIGHTER.

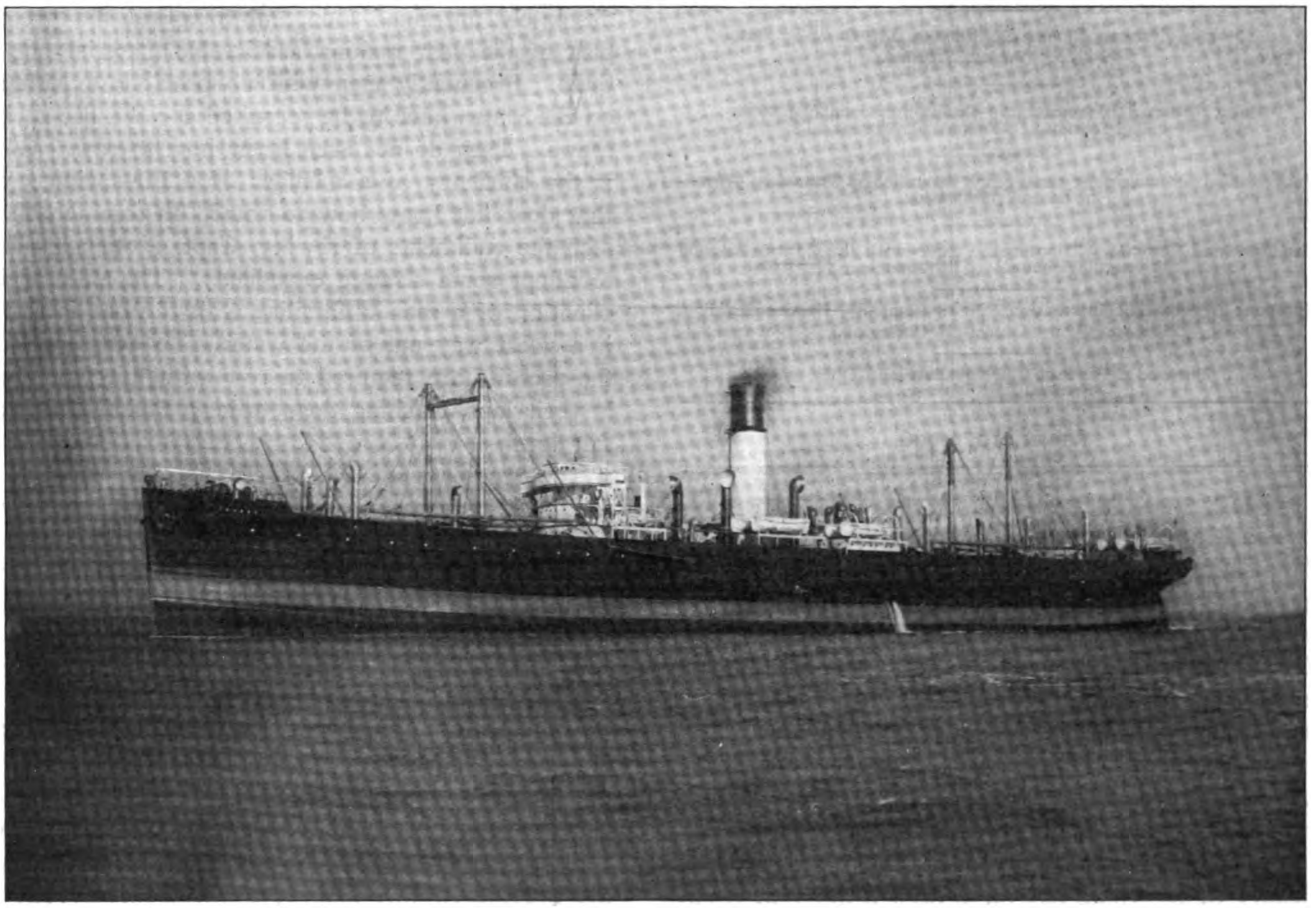
There are few ship-owning firms who are disposed to make radical departures from the usual methods of ship construction and design. It is therefore, the more interesting to see such a vessel as the Teucer which has been built on the Tyne for Messrs. Alfred Holt & Co., of Liverpool. She left the river last month (February) for Glasgow to load, and by the courtesy of the builders, Messrs. R. & W. Hawthorn, Leslie & Co., Ltd., of Hebburn, we are able to reproduce a photograph taken at sea on her trial.

Throughout many developments, steam vessels have always retained a certain amount of similarity to the sailing ship in their masts. Their spars have been shorn bit by bit but it has remained for Messrs. Holt to "go the whole hog." Instead of masts the Teucer has four large pillars placed two forward and two aft. These serve as derricks for lifting heavy weights and can stand the test of 36 tons. In fact the whole design of the vessel has been to make her suitable for her trade which will be in the far east. Her cargo gear can cope with the loading and discharge of her deadweight of 13,000 tons very rapidly. She had altogether 36 derricks and these are worked by 26 very powerful winches.

The dimensions of her hatchways will permit of bulky cargo, such as railway cars, boilers or the larger pieces of machinery being shipped, which is a great consideration in the general cargo trade. Clear holds have been obtained by doing away with the usual stanchions but the strength of the vessel has not been allowed to suffer by this concession to cargo carrying capacity, and the special details giving strength in the construction of the hull are very interesting.

The dimensions of the Teucer are: Length, 482 ft., 54 ft. beam, 42 ft. 6 in. depth and when fully laden she will carry 13,000 tons of deadweight cargo.

A house amidships contains the accommodation for the officers and engineers as the charthouse, etc., the navigating bridge being above. It will be noticed that the two forward pillars are joined by a bridge. This is about 80 ft. above the water line and in heavy weather will prove very useful for a lookout.



STEAMER TEUCER, NEW TYPE OF FREIGHTER.

Built by R. & W. Hawthorn, Leslie & Co., Ltd., Hebburn-on-Tyne.

Accommodation for about 350 emigrants has been placed aft under the shelter deck with all the necessary galleys, etc.

The vessel has twin-screw machinery and this has been constructed at the Wallsend Works of the North Eastern Marine Engineering Co. It consists of two sets of triple-expansion engines with cylinders 23 in., 38½ in. and 65 in. diameter with a stroke of 48 in., and three large boilers which work at a pressure of 190 lbs.

We understand that Messrs. Hawthorn, Leslie & Co., have another vessel in hand for Messrs. Holt of the same type as the Teucer which will probably be named the Antilochus.

THE MARINE REVIEW

DEVOTED TO EVERYTHING AND EVERY INTEREST CONNECTED OR ASSOCIATED WITH MARINE MATTERS ON THE FACE OF THE EARTH.

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MR. LONG'S COURSE WELL RECEIVED.

The MARINE REVIEW is gratified to announce that Mr. Clarence E. Long's course of scientific lake navigation which began in its issue of April 5 and which will continue throughout the year, has met with most flattering recognition, proving conclusively that modern conditions are demanding more from the men aboard ship than formerly. The progressive vessel owner is casting about for the navigator. Certain vessel owners have been free to admit that the demand for good men in responsible positions aboard lake ships is greater than the supply. Never in the history of the trade has there been better opportunities afforded to the younger element. There is no class of labor in the world that is better paid than labor aboard ship on the great lakes; nor, indeed, are the conditions which surround labor aboard ship approached in comfort elsewhere in the world. There is every inducement for young men to learn to become scientific navigators. That is why there is to be observed among the wheelsmen, and watchmen, young men of good breeding, of education and of ambition. A wheelsman is in direct line of succession to become mate, and the mate to become master. The course of scientific instruction which is now offered freely in the MARINE REVIEW is one which is well worth studying by every watchman, wheelsman, mate and master on the lakes. Bonaparte said that every soldier carried a marshal's baton in his knapsack. Every wheelsman on the lakes carries a master's license in his locker.

THE LIFE-SAVING SERVICE.

The life-saving service of the great lakes is now going into commission for the season of 1906. One of two things should be done with this service—it should either be made efficient or abolished altogether. Few people appreciate the straits to which the service has been reduced on the great lakes. There is so little inducement for really competent men to engage in the service that it is really difficult to get them. Take the life-saving station at Cleveland for instance. Capt. Motley, a very conscientious, painstaking and earnest official, has frequently to take into the service absolutely untrained men and to spend the greater part of the year making serviceable material out of them. Frequently men with no previous experience on the water have to be recruited for the life-saving crews. They do not even know how to row. What is the efficiency of a member of a life-saving crew that does not know how to row? In teaching these men the rudiments of rowing, Capt. Motley has had to adopt some strange expedients. The natural inclination of a man unfamiliar with the oar is to lift it a great way out of the water. To overcome this the recruits are required to row with life preservers in their laps, teaching them to keep their hands at a fair level.

The trouble with the service is that the pay is small, the tenure of office insecure, with the certainty of displacement as old age creeps on. The men on the lakes as a rule can make more money aboard ship and that is why they will not enter the life-saving service.

Senator Frye has offered a bill in the United States senate to remedy this deplorable condition of affairs. It creates a retired list for officers and surfmen with three-quarters pay after certain years of service. The committee on commerce has recommended the bill and it has also received the endorsement of Secretary Shaw of the treasury department. Common justice demands the passage of this bill. The life-saving service is not a fair weather service. It is a service which is only called upon to act under the most hazardous conditions. In responding to calls for aid, every member of the life-saving crew takes his life in his own hands. He is continually subjected to exposure. In fact, while there is shelter at some time or other for almost every service in the government, there is no shelter whatever for the life-saver. The history of the life-saving service is a succession of heroic deeds. In no country in the world is its lustre greater than in the United States. One has only to glance at the prosaic records of government reports to see how unfailingly loyal and brave the members of this service have been. The majority of the members succumb to

the rigors of the service. Few die natural deaths. Surely if there is any service at all that should be handsomely rewarded, it is the life-saving service; and yet of all the government services it is most niggardly dealt with. It is no wonder that men, after a season or two in it, leave for less hazardous and more profitable fields. The life-saving service on the great lakes is under present conditions not especially effective. It cannot be with raw and untrained crews to discipline into effective surfmen annually. A single season is not enough to give a man craftmanship to handle a boat in a heavy sea and rescue life at the same time. If the emoluments of the service are not sufficient to attract really desirable men, they should be made sufficient.

FREIGHT SITUATION.

Weather conditions for several days past have continued favorable to the opening of navigation and vessel owners in general are ordering the crews for their boats. The engineers of a number of fleets started fitting out on Monday last and the entire lake fleet will practically be ready to start next week. Ice in the straits of Mackinaw has broken up so that it became possible to navigate the straits on April 9. The Pittsburg Steamship Co. sent the steamers Bunsen and Black to Chicago with coal on Wednesday of this week. The steamer Cort left for Detour on Monday. The ice reports from Whitefish bay indicate that ice is quite solid there yet, so that no attempt will be made to send boats to Lake Superior for a few days at least. However, by the end of next week navigation will be generally under way unless something unforseen happens.

The labor situation has become a rather uncertain problem. The executive committee of the Lake Carriers' Association has closed with labor aboard ship with the exception of the firemen, oilers and watertenders, who are affiliated with the Longshoremen's association. It has not been possible as yet to even arrange a conference with this union. President Keefe of the Longshoremen's association not having replied to letters sent him. Nor has any date been arranged for a resumption of the conference between the dock managers and the representatives of the Longshoremen's association, which was abruptly terminated by the Longshoremen's association demanding, as a consideration for further negotiations, that the Lake Carriers' association recognize the mates' union. As the dock managers merely operate the terminals and have nothing whatever to do with labor aboard ship, they could not consent to the interjection of so extraneous an issue into their agreement. The conference thereupon terminated and nothing has been heard from Mr. Keefe since. The present agreement with the longshoremen continued until May 1, and as to what the condition may be after that date is a matter of some conjecture and considerable concern.

As a general thing it may be said that the stock piles of the leading steel-making companies are ample, probably sufficient for several months. This condition is not so, however, of the smaller furnaces.

Labor as a rule has fared well in its negotiations during the present year, whatever changes there have been made being to the advantage of labor. The package freight lines during the present week acceded to the demand for a third engineer on all boats over 3,000 tons.

The movement of ore will probably not be much greater this month than it was during April of last year. It is expected, however, that the total movement will exceed shipments of last year provided there is not a tie-up. The Steel Corporation has approximately the same carrying capacity that it had last year, but its natural requirements for ore will be somewhat greater. It will probably move as much, if not more, than it did last year. The stage of water is considerably lower than last year and vessel owners are advised not to load much deeper than 18 ft. for first trips.

CONTRACT FOR D. & C. STEAMER AWARDED.

The American Ship Building Co. has secured the contract to build the new passenger steamer for the Detroit & Cleveland line to come out in 1907. This steamer, which was designed by Mr. Frank E. Kirby, will be built at the Wyandotte yard. The new steamer will be 400 ft. long, 54 ft. beam, 90 ft. over guards and 22 ft. depth of hold. She will be propelled by three cylinder compound engines of 7,000 H. P., supplied with steam from eight cylindrical boilers. Her passenger excursion limit will be 4,500. She will be the largest passenger steamer on fresh water.

AROUND THE GREAT LAKES

The new McMyler car dump machine which is being installed at the Pittsburg Coal Co.'s dock, at Fairport, is nearly completed.

The scow David Moran, belonging to the fleet of the Kelly Island Lime & Transport Co., has been given an entire rebuild by Dixon Bros., Fairport.

The Kendall Marine Reporting Co. at Port Huron will be managed this season by Capt. J. E. Meno who has had many years' experience on the lakes.

The executive committee of the Lake Carriers' Association met last week and adopted touching resolutions in memory of the late Henry A. Hawgood.

Mr. G. A. Tomlinson, of Duluth, has been elected a member of the executive committee of the Lake Carriers' Association in place of the late Henry A. Hawgood.

The second steamer building for Wm. A. Hawgood and Capt. Arthur H. Hawgood at the Lorain yard of the American Ship Building Co., will be named for Henry D. Smith of Bay City.

The marine post office at Detroit has resumed operations in part. The mail boat Florence B is at present undergoing repairs at Oades' ship yard, and mail for the present will be delivered by row boats.

The Benton Harbor Development Co. will shortly open up some 150 acres of marsh land for developing purposes. City Engineer Wightman has drawn up plans for a ship canal as a part of the development.

The Duluth-Superior harbor front is beginning to present the usual sights that accompany the opening of navigation. Five of the tugs of the Union Towing & Wrecking Co. are being fitted out to shift the freighters in the harbor.

The Scottish King, a British freighter, now plying in the Cape Breton and Nova Scotia trade, is to be brought to the great lakes by the Canadian Lake & Ocean Navigation Co. As she is in excess of Canadian canal dimensions, she will be cut in two at Quebec.

The New York Harbor of the American Association of Masters and Pilots of Steam Vessels has raised more than $1,000 for the defense of Capt. Van Schaick, of the steamboat General Slocum, who was sentenced to ten years' imprisonment on account of the burning of that vessel.

The Barnett & Record Co., contractors, are making satisfactory progress upon the new ore dock for the Duluth, Mesabi & Northern road at Duluth. This will be the largest dock in the world, being 2,350 ft. long, 60 ft. wide and 72½ ft. high. It is expected that it will be finished in August.

LIVERPOOL SHIPPING LETTER.

Liverpool, April 2.—The annual report of the North German Lloyd Shipping Company shows that during 1905 an aggregate number of 449,243 passengers were conveyed by the company's ocean-going steamships as compared with an aggregate number of 358,686 in 1904. The completion of the new large steamship Crown Princess Cecilie which will be ready for sea in August will enable the company to maintain a fast weekly service between Bremen and New York. Hitherto the company has been unable to run a fast steamship every week, but has alternated the big fast steamships with slower vessels requiring one or two days longer to cross the Atlantic. It is noteworthy that the company have cancelled the instructions originally given to fit out the Crown Princess Cecilie with turbines. The report states that the board of directors came to this decision after systematic tests of the value of turbines for large ocean-going steamships. The number of passengers conveyed to ports in the far east and to Australia showed a considerable increase on all former years. The report expresses the expectation that the new line of cargo steamships established between Bremen and Australian ports will prove extremely valuable to the development of German trade in Australia. The profits for 1905 amounted to $8,250,000. The sum of approximately $75,000 was paid by virtue of the existing agreement to the International Mercantile Marine Company. A dividend of 7½ per cent is declared.

The Empress, a finely modelled steel twin-screw mail and passenger steamer has been just launched by Messrs. Swan, Hunter and Wigham Richardson, Ltd., for the Charlottetown Steam Navigation Company, Ltd., of Charlottetown, Prince Edward Island, for their service between Prince Edward Island and the mainland. The Empress is a sister ship to the Northumberland built by the same builders for the same owners 15 years ago. The new vessel will carry over 500 passengers, together with cargo, and is 235 ft. in length, by 34 ft. beam. She is built to class 100 A1 at Lloyds, and will also have a Board of Trade passenger certificate, as well as fulfil all the requirements of the Canadian law. The propelling machinery consists of twin-screw triple-expansion engines, supplied with steam from two large boilers which are all being constructed by the builders of the vessel to drive her at a speed of 16½ knots per hour.

Once more is an attempt to be made to cultivate a direct trade between Hull on the east coast of Britain and Canada, this time under the auspices of Messrs. Cairns, Noble & Co., Newcastle-On-Tyne, Messrs. W. Brown, Atkinson & Co., Ltd., Hull. and the Thomson Line, Dundee. At the end of April the Thomson Line steamer Fremona will be put on the berth at Hull to load for Montreal and Quebec, and should sufficient business be forthcoming, a regular service will be kept up. The Canadian Commissioner at Leeds has been very actively engaged in Hull during the past few months endeavoring to create a direct trade between the east coast of Britain and the Dominion. Large quantities of Canadian produce are consumed in the east of England, the greater part of which comes by way of Liverpool, and London, and direct shipments are now desired. The corn, timber and fruit merchants may be relied on for homeward cargo, so that the only difficulty will be the outward cargo.

The directors of the Cunard Steamship Co., Ltd., after providing for full depreciation and placing $250,000 to the credit of the reserve fund, have decided to recommend a dividend of four per cent per annum for the year 1905. Last year the revenue of the company was affected owing to the prevalence of the Atlantic rate war, and no dividend was paid, but a sum of about $38,000 was carried forward. For the three previous years 1901, 1902, and 1903, a distribution equivalent to that for 1905 was paid.

The new Canadian Pacific liner, Empress of Britain, now completing her outfit on the Clyde, will, it is hoped, run her builders' trials on April 9, and undertake the official trial trip on or about April 14. Engine tests which have been made in the dock have given entire satisfaction.

The United States Mercantile Marine may be interested in the Workmen's Compensation Act which has been introduced into the British Parliament providing for compensation to be given to seamen and apprentices to the sea service who suffer injury through accident. The clause relating to seamen's compensation reads as follows:

(a) The notice of accident and the claim for compensation may be served on the master of the ship as if he were the employer, but where the accident happened and the incapacity commenced on board the ship it shall not be necessary to give any notice of the accident:

(b) In the case of the death of the seaman or apprentice, the claim for compensation may be made within six months after news of the death has been received by the claimant:

(c) Where an injured seaman or apprentice is discharged or left behind in a British possession or in a foreign country, depositions respecting the circumstances and nature of the injury may be taken by any judge or magistrate in the British possession, and by any British consular officer in the foreign country, and if so taken shall, in any proceedings for enforcing the claim, be admissible in evidence as provided by section six hundred and ninety-one of the Merchant Shipping Act, 1894, and may be authenticated in manner provided by that section:

(d) In the case of the death of a seaman or apprentice leaving no dependants, no compensation shall be payable, if the owner of the ship is, under the Merchant Shipping Act, 1894, liable to pay the expenses of burial:

(e) The weekly payment shall be payable as from the date when the injured seaman or apprentice is brought back to the United Kingdom:

(f) Any sum payable by way of compensation by the owner of a ship under this Act shall be paid in full notwithstanding anything in section five hundred and three of the Merchant Shipping Act, 1894 (which relates to the limitation of a shipowner's liability in certain cases of loss of life, injury, or damage), but the limitation on the owner's liability imposed by that section shall apply to the amount recoverable by way of indemnity under the section of this Act relating to remedies both against employer and stranger as if the indemnity were damages for loss of life or personal injury:

(g) Sub-sections (2) and (3) of section one hundred and seventy-four of the Merchant Shipping Act, 1894 (which relates to the recovery of wages of seamen lost with their ship), shall apply as respects proceedings for the recovery of compensation by dependants of seamen and apprentices lost with their ship as they apply with respect to proceedings for the recovery of wages due to such seamen and apprentices; and proceedings for the recovery of compensation shall in such a case be maintainable if the claim is made within eighteen months of the date at which the ship is deemed to have been lost with all hands.

(h) Where any matter under this act is to be done in a county court, or by, to, or before the judge or registrar of a county court, it shall be done in, or by, to, or before the judge or registrar of such county court as may be prescribed by rules of court.

The clause finds no material objection among ship owners, and will probably become law with possibly one

or two minor amendments made when the bill reaches the committee stage.

With the arrival of the Allan Line steamer Virginian at Halifax on Thursday, March 29 at 9 P. M., was completed the first trans-Atlantic passage this year of the turbine steamers built for the service between England and Canada. The passage constituted a record for the Halifax route, as she landed the mails in 6 days 11 hours after leaving Moville on March 23. No fewer than 1,620 passengers traveled in the ship, and the greatest satisfaction was expressed with the vessel and all the arrangement made for their comfort. The liner has just undergone a thorough overhaul in Liverpool, and starts her second season under the most favorable auspices. The sister turbine, Victorian, sails from Liverpool on her first voyage on April 5, and it is confidently expected that she will rival the Virginian in speed. This vessel has just undergone a thorough overhaul at Belfast. These two magnificent liners made a reputation last year, and they will undoubtedly be the favorites again this year in the Canadian service owing to the smooth running of the turbines, the exceptional steadiness of the ships, and the general excellency of the accommodation provided.

MANCHESTER'S UNIQUE POSITION AS AN INLAND PORT.

A paper was read before the Manchester Association of Engineers on March 23 on "Harbors, Docks, and their Equipment," by Mr. W. H. Hunter, chief engineer of the Manchester ship canal. Mr. Hunter sketched the history of the great development of maritime enterprise in Britain during the last half century, and in particular the marvelous increases in the size and speed of ocean-going ships. The effect of these advances in ship building upon harbor and dock construction must, he said, be apparent. In 1855, the depth of water upon the bar of the Mersey eleven miles from the rock light, which governed the draught of all the vessels trading to and from Liverpool, was 11 ft. From 1855 to 1890 the depth fluctuated from 7 ft. to 17 ft., according as the effects of wind, wave, and flood were favorable or otherwise. Operations, first of a tentative and afterwards of a more determined sort, were taken in hand for the removal of the bar by means of hydraulic dredging. These operations (which were begun in 1890) proved, under the direction of the present engineer-in-chief to the dock board, to be entirely successful. The depth which was gained by the working of the sand pumps has been maintained by the same means, so that the present depth in the channel where the bar used to be is 27 ft. below low water of spring tides, a quantity of some 35,000,000 cu. yds. of sand having been removed from the site of the bar between 1890 and the end of 1905.

As one example of the work accomplished in modern ports the figure relating to the most modern of them all, the port of Manchester, were quoted. The area of the water space of the Manchester docks is 136 acres, with 14 acres in reserve for dock No. 10; the area of land space around the docks is 353½ acres, the length of quay frontage 6 2-3 miles, and the depth of water on sills of entrance locks 28 ft. "Manchester occupies at the present time," Mr. Hunter said, "a unique position amongst the ports of the world, in that it presents the first example of the second stage of an engineering development which has taken place in response to the imperative demand for cheaper conveyance of imports, such as raw material, and food products, and of exports, such as manufactured goods and minerals. In order to meet the demand it became necessary to effect a severance between the harbor space and the dock accommodation, which in the olden times were joined together in what seemed to be indissoluble wedlock. The harbor space seemed to be on coastline, and there originally the dock accommodation was provided.

"So long as manufacturers could obtain almost any prices they choose to ask for their goods, cost of conveyance from dock to mill and from mill to dock was of comparatively small importance. But when prices had to be cut owing to fierce and strenuous competition, and when even with cut rates the trade was found to be declining in the inland districts, the demand for cheaper carriage led to the obvious suggestion that, while it was inevitable that the harbor should remain on the coast, it was possible and desirable to provide the dock accommodation where the works and mills were situated, and where the population to be fed had its domicile and place of occupation. From the enterprise which created the inland port of Glasgow by the regulation and deepening of an ineffective stream to the enterprise which created the inland port of Manchester by the formation of an entirely artificial waterway is but one step, and the two taken together will serve to illustrate the stages in the way of dividing the harbor from the dock, and thus of providing the cheapest possible carriage for large cargoes and goods in bulk."

CAPT. DONNELLY'S LECTURES APPRECIATED.

That the marine lectures which Capt. Thomas Donnelly gave at Kingston during the winter months were fully appreciated is clearly evidenced by the testimony of his hearers. The following appreciation was read to Capt. Donnelly at the close of the term:

"The Kingston association of masters and mates desires to express their earnest appreciation of, and the benefit your marine lectures have been to them during the season about closing. We are aware that much thought and labor was necessary in the preparation of these lectures, and we fully believe that you have not spared any and every effort to make them both interesting, and profitable to those who were fortunate enough to attend. These lectures have been alike useful to old as well as young mariners, and the knowledge we have acquired has certainly increased our usefulness to our employers, and has made us feel a much greater degree of admiration for our profession. The steady attendance of our sailors and yachtsmen is a proof of the very great interest which the marine men of this vicinity have taken in the marine schools and we feel that the marine men of this vicinity have much to be thankful for in being privileged to attend it. Already steps have been taken to bring your merits and work to the notice of the department of marine and fisheries, and we sincerely hope that department will continue the good work which has been so ably carried forward this winter under your supervision."

MOTIVE POWER ON PILOT BOATS.

The question of installing motive power in the pilot boats of San Francisco is now being seriously considered by the pilot commissioners, and apparently the only thing that precludes immediate action is the question whether gasoline or electricity is the more practicable. When this point has been settled, two of the pilot boats will be equipped at once with power, and if they prove successful, similar work will be done on all the other boats in the pilot service. The gasoline or electric pilot boat will be hailed with delight by the masters of all the great liners. At the present time it almost invariably happens that the steamships have to go several miles out of their regular course to pick up the pilot.

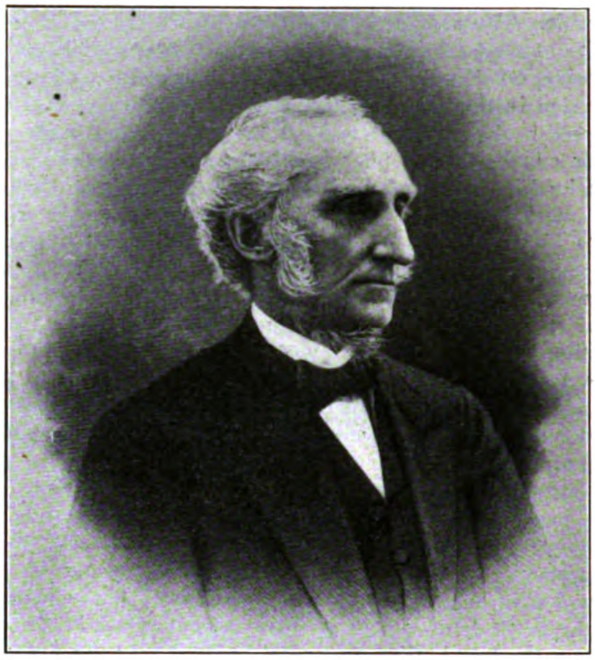
Herr Ballin stated at a meeting of the Hamburg-American Steamship Co., at Berlin last week, that the results obtained with turbine engines in large ocean steamships did not warrent their substitution for the ordinary form of reciprocating engine.

LAUNCHING OF STEAMER JAMES LAUGHLIN.

MISS ALICE D. LAUGHLIN.

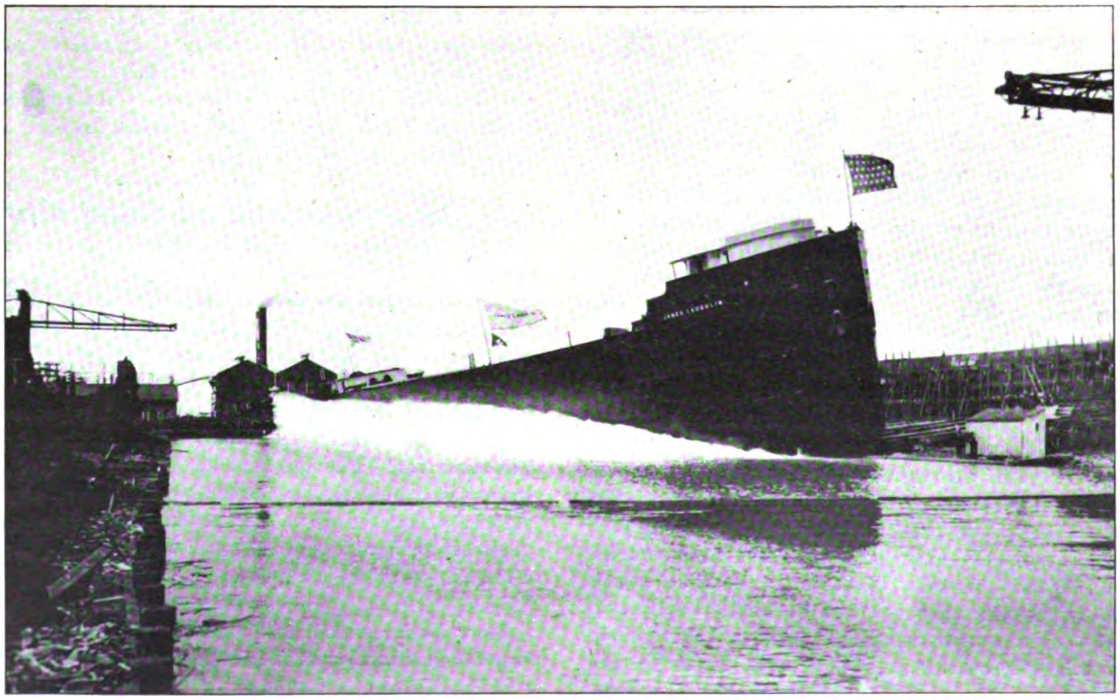
The launching of the great steamer James Laughlin at the Ecorse yard of the Great Lakes Engineering Works on Saturday last was in every way successful and the occasion a delightful one, owing to perfect weather, to the launching party. The hull of the great steamer slipped into the water shortly before noon and was christened by Miss Alice D. Laughlin, of Pittsburg, the great-grand-daughter of the man after whom the ship was named. On the launching stand were the following: Mr. and Mrs. J. D. Laughlin, Miss Laughlin, Miss Alice D. Laughlin, Mr. and Mrs. W. L. Jones, G. M. Laughlin Jr., Hubert H. Laughlin, Mr. and Mrs. Robert Totten, and Robert Gerry, of Pittsburg; Mr. and Mrs. W. G. Pollock, W. H. Becker, Capt. George Symes, Mrs. Symes, Frank H. Masten, George Randerson, Dr. A. Morrison, Frank Morrison and Capt. C. M. Ennes, of Cleveland; Mr. and Mrs. W. L. Clements, of Bay City, and Mr. and Mrs. Antonio C. Pessano, Miss Pessano, Mr. and Mrs. H. P. Holt, Miss Annie Russel, John R. Russel, Mr. and Mrs. Dewitt Loomis, Mr. and Mrs. Cameron D. Waterman Jr., and Mr. and Mrs. John Avery, of Detroit.

MR. ROLLAND GERRY AND MR. W. G. POLLOCK.
Mr. Pollock is giving Mr. Gerry a few tips.



JAMES LAUGHLIN.

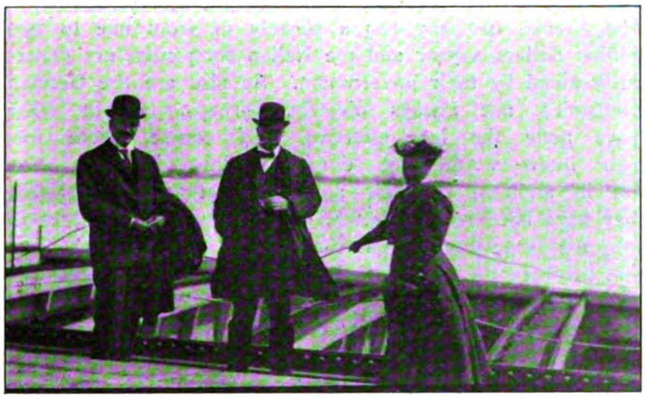
The steamer James Laughlin is a duplicate of the B. F. Jones, recently launched at this yard, and is 550 ft. over all, 530 ft. keel, 56 ft. beam and 31 ft. deep. She has thirty-three hatches, spaced 12-ft. centers, and is equipped with triple-expansion engines 23, 37 and 63-in. cylinder diameters by 42-in. stroke, supplied with steam by two Scotch boilers, 15 ft. by 12 ft., fitted with induced draft and allowed 175 lbs. pressure. She will go into commission



THE LAUNCHING OF THE STEAMER JAMES LAUGHLIN. *Copyright 1906 by Detroit Publishing Co.*

about May 15, thus forging another link in the great chain which is connecting the great steel-making plants with the sources of their raw material.

A dinner was given at the Detroit club during the afternoon to all the guests attending the launch. Remarks were made by Mr. James P. Laughlin, Mr. Wm. L. Jones, Mr. Frank Masten, Mr. Wm. H. Becker, Mr. Wm. G. Pollock, Capt. Symes and Capt. Ennes, but nothing in special was touched upon by the speakers, the whole occasion being one of good fellowship.



MR. ROLAND GERRY, MR. W. G. POLLOCK AND MRS. A. C. PESSANO.
Mr. Pollock is explaining all about a ship.

CAPT. HILL, W. H. BECKER, FRANK MASTEN, HORATIO HERRIMAN AND H. C. SADLER.

APPOINTMENTS OF MASTERS AND ENGINEERS.

PITTSBURG STEAMSHIP CO., CLEVELAND, O.

Vessel.	Captain.	Engineer.
Str. Bessemer	W. S. Hoag	A. G. Haig
Str. Black	M. A. Boyce	John Hegemer
Str. Briton	George Holdridge	J. E. Marshall
Str. Bunsen	J. W. Morgan	Frank Mansfield
Str. Cambria	———	W. P. Diamond
Str. Colgate	A. G. McLeod	James Hyde
Str. Coralia	W. H. Campau	A. P. Williams
Str. Corey	F. A. Bailey	M. Toner
Str. Cornell	W. H. Kilby	G. C. Lawrence
Str. Corona	J. T. Gemmel	J. H. Riggin
Str. Corsica	H. J. Regan	Thos. McKenzie
Str. Cort	F. A. Ferguson	C. L. Birtrand
Str. Crescent City	———	———
Str. Eads	Arthur Montague	C. A. Fletcher
Str. Edenborn	———	———
Str. Ellwood	C. H. Cummings	Levi Walder
Str. Empire City	James Burr	S. H. Hunter
Str. Ericsson	E. O. Whitney	A. P. Williams
Str. Fairbairn	C. J. Grant	Thos. Treleaven
Str. Frick	Neil Campbell	D. Frazer
Str. Fulton	C. J. Ennis	George Arnold
Str. Gary	Richard Jollie	John Dupont
Str. Gates	J. A. Walsh	E. J. Fitzgerald
Str. German	J. C. Bell	Wm. D. Killett
Str. Gilbert	E. Dyble	W. G. Tilton
Str. Grecian	Andrew Hansen	A. J. Armson
Str. Griffin	E. L. Sawyer	H. E. McIntosh
Str. Harvard	A. R. Robinson	Ed. Egan
Str. Hill	George Bell	E. S. Stoddard
Str. Houghton	E. M. Smith	J. W. McEachren
Str. Joliet	W. E. Stover	D. Milloy
Str. LaSalle	Thomas Wilson	R. B. Huston
Str. Linn	George Banker	Herman Dupont
Str. McDougall	John Nahrstedt	James Inman
Str. Malietoa	A. C. Chapman	A. E. Buddemeyer
Str. Manola	H. G. Harbottle	J. J. Norcross
Str. Maricopa	John Parke	A. T. McLeod
Str. Marina	A. C. Smith	F. J. Spencer
Str. Mariposa	R. F. Humble	Wm. Clucas
Str. Mariska	A. R. Thompson	Neil McNeil
Str. Maritana	John Noble	J. W. Parr
Str. Maruba	F. C. Watson	B. Cassidy
Str. Masaba	C. A. Weitzman	J. H. McGlenn
Str. Mataafa	———	———
Str. Mather	C. S. Boyce	J. A. Bennett
Str. Matoa	H. Gegoux	E. J. Rae
Str. Maunaloa	J. La Framboise	Alex. McKenzie
Str. Morgan	A. P. Chambers	———
Str. Morse	John Lowe	E. W. Fox
Str. Murphy	A. J. Talbot	Henry Annett
Str. Neilson	T. J. Cullen	Gus. Johnson
Str. Palmer	J. H. Clapp	E. R. Leedham
Str. Perkins	W. H. Moody	F. A. Smith
Str. Poe	W. C. Iler	Wm. Densmore
Str. Princeton	D. P. Wright	W. L. Campbell
Str. Queen City	C. Geggenheimer	E. H. Learned
Str. Rensselaer	S. C. Allen	Irwin Marshall
Str. Rockefeller	Frank Rice	J. B. McDermid
Str. Rogers	James Leisk	———
Str. Roman	George Randolph	Wm. Dornbrook
Str. Saxon	George H. Bowen	Richard Mastin
Str. Shaw	John Burns	George Lynn
Str. Siemens	M. K. Chamberlain	Duncan McVicar
Str. Stephenson	W. B. McGregor	S. W. Armstrong
Str. Superior City	F. J. Crowley	M. B. Sturtevant
Str. Trevor	H. Walper	Wm. Bourlier
Str. Van Hise	Fred Hoffman	H. E. Schmidt
Str. Watt	W. J. Hunt	A. W. Armson
Str. Wawatam	———	James Dugan
Str. Wolvin	C. D. Secord	Harry W. Firby
Str. Zenith City	H. Culp	A. Jackson
New Boat	———	Fred Warning
		J. F. Wood
Bge. Bell	C. Mulholland	Alex Graham
Bge. Bryn Mawr	Geo. B. Kendall	C. C. Carroll
Bge. Carrington	J. H. Denner	A. B. Hill
Bge. Corliss	George Balfour	Fred Wright
Bge. Fritz	John Y. Sprowell	A. J. McLarty
Bge. Holley	H. T. Kelly	J. E. Johnson
Bge. Jenney	A. Nordahl	Fred Stone
Bge. Krupp	F. H. Rae	Mark Lange
Bge. Magna	H. M. White	R. C. Heider
Bge. Maia	W. H. Dick	Wm. J. Lavigne
Bge. Maida	O. W. Holdridge	Charles Coster
Bge. Malta	David Bouille	Wm. Danforth
Bge. Manda	H. Harris, Jr.	Charles Huber
Bge. Manila	———	———
Bge. Marcia	Geo. Maloney	C. F. McConville
Bge. Marsala	Louis Leonard	A. A. Woods
Bge. Martha	J. H. Dissett	John Rolison
Bge. Nasmyth	Donald Graham	Charles Somers
Bge. Roebling	H. M. Saveland	J. W. Abel
Bge. Smeaton	J. R. Parker	W. H. Stalker
Bge. Thomas	David Williams	Nick Lahart
Bge. 117	Charles Gadon	Victor Pouchea
Bge. 118	Louis Larsen	Fred Brenner
Bge. 130	Fred Kirk	L. W. La Vooe
Bge. 131	Alfred Beaupre	Louis Algrin
Bge. 132	Chas. Thompson	Aug. Peterson
Bge. 133	Robt. Thompson	D. Thompson
Bge. 134	A. H. Hand	J. R. McLaren
Bge. 137	Wm. McDonald	Aug. Carlson

The ice jam which had formed in St. Clair river was broken this week and the fleet of vessels consisting of the Rodgers, Clyde, Packer, Fleetwood and Barge Moravia which had been held up near Mackinac, moved out into Lake Huron. As the straits are free they will in all probability reach Lake Michigan without any trouble.

MERCHANT MARINE LEAGUE.

The Merchant Marine League of the United States is now distributing a pamphlet throughout the country containing the sayings of three presidents on the subject of aid to shipping in the foreign field. The sayings make a booklet of fourteen pages. It is distributed by the league to anyone upon request. Three of the sayings which are printed as a frontispiece are as follows:

Benjamin Harrison: Our great competitors have established and maintained their lines by government subsidies, until they have now practically excluded us from participation. In my opinion, no choice is left to us but to pursue, moderately at least, the same lines.

William McKinley: I am satisfied the judgment of the country favors the policy of aid to our merchant marine, which will broaden our commerce and markets and upbuild our sea-carrying capacity for the products of agriculture and manufacturing.

Theodore Roosevelt: Ships work for their own countries, just as railroads work for their terminal points, from every standpoint it is unwise for the United States to continue to rely upon the ships of competing nations for the distribution of our goods. It should be made advantageous to carry American goods in American-built ships.

Frequently the charge is made that a powerful lobby is at work in Washington in behalf of the ship subsidy bill. To anyone familiar with the facts this charge is a cause of sarcastic merriment. Every Washington newspaper correspondent knows that there is no such lobby here. But there is a lobby at work with rich and powerful backing. How many agents it has here is not known but as it is composed of the foreign steamship companies each of which is represented in this city, they are not few. Most of the work, however, is done from New York and crops out in various parts of the country. American shipping companies, the few there are in the foreign trade, do not pretend to watch or interfere with the action of foreign governments in subsidizing their ships nor do they maintain lobbies at London, Paris or Berlin. They assume that if the British, French or Germans wish to subsidize their merchant marine it is their own business and foreigners have no legal or moral right to interfere.

But the great British, French, German and Italian corporations which now monopolize most of our ocean trade appear to look at this question differently. Several over-zealous agents of these foreign steamship companies appeared as uninvited witnesses at the hearings of the Merchant Marine Commission and apparently took it as a personal affront that the president of the United States should recommend that congress should authorize an inquiry as to the best method of gaining some control of our own carrying trade for the ships and seamen of America. Of course, there is a good reason for the opposition of foreign steamship companies to an American ship subsidy. About $180,000,000 annually is paid to them in freight on our commerce. Moreover, if through the passage of the subsidy bill new lines of efficient American steamers were established to the ports of South America and South Africa, American manufacturers, merchants and farmers would have a better chance of selling their goods in competition with those of Great Britain, France and Germany where they are now effectually handicapped by reason of the few, very ineffective and irregular foreign steamship service from the United States to South Amercia and South Africa.

Consequently the North Atlantic steamship companies which have grown rich and powerful out of American trade are watching with unconcealed chagrin the prospects of the shipping bill in the house of representatives. It is rather grotesque—this opposition of foreign steamship companies, most of them heavily subsidized, to the pending shipping bill. The Cunard company, for instance, is about to enter upon a contract calling for an annual subsidy of $1,000,000 for twenty years. It is estimated that under the American shipping bill one million dollars would at the start subsidize nearly all the American ships engaged in the foreign trade. The French company has a subsidy of from one to two million dollars a year and the Italian companies, are generously aided by their government. So also are the German companies, not always directly, perhaps, but in other ways none the less effective. Of course, these foreign interests do not dare to fight in the open, but in addition to their agents operating as witnesses, they have been sending letters as individuals to members of congress protesting against the bill but concealing the fact that they are the agents of the foreign steamship companies. The shipping committee of a certain New York commercial organization is also flooding congress with protests against the bill. It is not likely, however, that the members of congress receiving these protests are aware that the chairman of the committee drafting and signing them is a member of a firm operating a line of slow steamships to South America under a foreign flag. Nor do they likely know that the first vice president of the same association is the New York representative of a German steamship company which has a subsidy of $1,330,000 a year for its East Indian and Australian service. Such awkward facts as these are kept in the background. There is a certain commercial newspaper in New York city which for years has carried nearly an entire page of advertisements of foreign steamship companies. It is scarcely necessary to add that this newspaper always fought editorially and in its news columns with exceeding bitterness every effort to build up the American merchant marine whether by discriminating duties, subsidies or in any other manner. This commercial newspaper does not circulate widely through the country but since the shipping bill has been before congress this session marked copies of its editorials attacking American shipping have been sent to a large number, if not all the newspapers in the Mississippi valley and the southern cotton belt. It would be interesting to know whether these copies were bought and marked by American or foreign interests and whether the expenditure was not defrayed directly or indirectly by concerns for the solicitors' agents in New York city but with headquarters in Liverpool, London, Havre, Hamburg and Bremen. Many newspapers have reprinted the editorials from this commercial newspaper believing it to be an authority on the subject but overlooking what is practically a subsidy for this paper in the form of the foreign steamship advertising. Unfortunately American shipping except in the lake and coastwise trade is so insignificant as to have no advertising at its disposal.

Various changes occurred April 1, in the personnel of the Stanley-G. I. Electric Mfg. Co.'s representation on the Pacific coast. Mr. F. V. T. Lee has resigned the position of district manager to become assistant to the president, Mr. John A. Brittin, of the Pacific Gas & Electric Co. Mr. H. C. Parker who has been manager of the San Francisco office became acting district manager and Mr. G. I. Kinney, who has been manager of the Seattle office will be associated with Mr. Parker with headquarters in San Francisco. Mr. Lee's connection with Stanley interests on the Pacific coast dates back to the organization of the firm of Jno. Martin & Co., who were for many years, especially during the time of the pioneer long distance electric transmission work of that section, the Stanley company's Pacific coast representatives. Messrs. Parker and Kinney were also associated with the Jno. Martin Co. prior to the time of the Stanley company establishing their own branch offices on the Pacific coast.

SHIP BUILDING IN THE UNITED STATES.

The bureau of navigation reports 202 sail and steam vessels of 106,834 gross tons built in the United States and officially numbered during the quarter ended March 31, 1906, as follows: .

	WOOD				STEEL		TOTAL	
	Sail		Steam		Steam			
	No.	Gross	No.	Gross	No.	Gross	No.	Gross
Atlantic and Gulf	35	5,344	84	4,969	10	9,577	129	19,890
Porto Rico..............	....	......	....	....	....	....	....	.. ....
Pacific	3	846	21	1,051	1	347	25	2,244
Hawaii..................	..	......	....	...	....	....	..	....
Great Lakes............	....	....	6	94	18	83,748	19	83,837
Western Rivers........	..	......	28	766	1	97	29	863
Total	38	6,190	139	6,880	25	93,764	202	106,834

During the corresponding quarter ended March 31, 1905, 159 sail and steam vessels of 62,744 gross tons were built in the United States and officially numbered, as follows:

	WOOD				STEEL		TOTAL	
	Sail		Steam		Steam			
	No.	Gross	No.	Gross	No.	Gross	No.	Gross
Atlantic and Gulf.....................	35	6,704	46	1,912	10	31,628	91	40,244
Porto Rico...............	8	25	....	....	....	....	8	25
Pacific	2	14	22	1,162	....	....	24	1,176
Hawaii	....	......	....	....	......	....	....	....
Great Lakes.............		......	2	21	6	20,174	8	20,195
Western Rivers..........	....	......	33	1,104	....	....	33	1,104
Total	40	6,743	103	4,199	16	51,802	159	62,744

The bureau of navigation reports 744 sail and steam vessels of 242,931 gross tons built in the United States and officially numbered during the 9 months ended March 31, 1906.

	WOOD				STEEL				TOTAL	
	Sail		Steam		Sail		Steam			
	No.	Gross	No.	Gross	No.	Gross	No.	Gross	No.	Gross
Atlantic and Gulf..	183	25,504	246	10,798	4	2,551	87	28,420	470	67,273
Porto Rico	2	15	....	....	....	......	....	....	2	15
Pacific.........	17	2,742	65	3,760	....	......	1	347	83	6,849
Hawaii.........	....	......	....	....	....	......	....	....	....	....
Great Lakes...	5	157	37	909	....	......	34	164,675	76	165,741
Western Rivers	....	......	109	2,604	....	......	4	449	113	3,053
Total........	207	28,418	457	18,071	4	2,551	76	193,891	744	242,931

During the corresponding 9 months ended March 31, 1905, 701 sail and steam vessels of 155,342 gross tons were built in the United States and officially numbered, as follows:

	WOOD				STEEL				TOTAL	
	Sail		Steam		Sail		Steam			
	No.	Gross	No.	Gross	No.	Gross	No.	Gross	No.	Gross
Atlantic and Gulf ...	230	63,884	169	6,600	2	662	85	48,583	436	119,729
Porto Rico....	5	47	..	....	....	......	..	....	5	47
Pacific.........	18	2,869	79	5,099	.. .	......	....	....	97	7,968
Hawaii	....	......	....	....	....	......	....	....	....	....
Great Lakes...	12	166	22	450	....	....	11	22,672	45	23,288
Western Rivers	....	......	117	4,291	....	....	1	19	118	4,310
Total	265	66,966	387	16,440	2	662	47	71,274	701	155,342

URGES PASSAGE OF SHIPPING BILL.

Edward P. Williams, head of the Ely & Williams Co., of New York, sales agents for iron and steel products, has sent a letter to Joseph G. Cannon, speaker of the house of representatives, urging the passage of the ship subsidy bill now pending in the house, and which has already passed the senate. Mr. Williams calls it the most important measure before congress. His letter reads as follows:

"The congress of the United States ought to have enough intelligence, patriotism, and honesty to enact laws affording sure protection to all American industries exposed to foreign competition. For about forty years, successive congresses have refused 'a square deal' to our international marine transportation business, resulting in enormous losses to our mechanical and agricultural laborers, amounting to thousands of millions of dollars. An American built ocean steamer costs the nation nothing but the waste incidental to its construction; its value represents the amount of wealth created by labor; and this wealth is distributed among all the industries concerned, most of it going to farmers and others who furnish materials for food, clothing, fuel, etc., required by laborers, who produce, or transport, the materials of all sorts, and the machinery used in its construction, and by those who build the steamer. Foreign built steamers cost the United States the amounts of money sent abroad to pay for them. The wealth they represent has been added to that of the countries where they were built, thus sustaining foreign industries instead of our own. It is, therefore, impossible that a foreign built ship can be as cheap to the nation, as one of American construction. The demand for "free ships" is a fraud in purpose, and intended to deceive, or shows ignorance. Liberal mail contracts, and land grants of enormous value, have been given to our railroads with magnificent results, while niggardly parsimony has prevailed in our treatment of American ship builders and ocean steamship companies struggling to engage in foreign commerce with disgraceful consequences. Let the eyes of our people now be fixed upon the members of congress, while they debate and vote upon the shipping bill, which has been passed by the senate, and let us then deal with them as each shall deserve. The shipping bill is in fact, the most important measure before congress, and upon its fate now may depend seriously our national future.

Why should a Christian nation expend millions of dollars for war vessels (being only another form of protection) that produce nothing except expenses; and pretend that the United States treasury is too poor to deal justly by our shipping interests, refusing to them the protection essential to competition with subsidized foreign shipping lines, while favoring foreign ship builders in neglecting to tax their product when engaged upon American business with foreign countries?"

PROGRAM, INSTITUTION OF NAVAL ARCHITECTS.

The Institution of Naval Architects met at the office of the institution, 5 Adelphi terrace, London, W. C., England, on April 4, 5 and 6. The following papers were read at the sessions:

"The New Scouts," by Admiral C. C. P. Fitzgerald; "Vessels Constructed for Service in our Colonies and Protectorates," by Sir Edward J. Reed; "Yacht Racing Measurement Rules and the International Conference," by R. E. Froude; "The Speed of Motor Boats and their Rating for Racing Purposes," by Linton Hope, Esq.; "The Design and Construction of High Speed Motor Boats," by James A. Smith, Esq.; "Gas Engines for Ship Propulsion," by J. E. Thornycroft, Esq.; "The Efficiency of Surface Condensers," by Prof. R. L. Weighton, Member; "Notes on the Freeboard Rules," by J. Foster King; "The Overhead Wire Cableway Applied to Ship Building," by J. L. Twaddell; "The Introduction of Cranes in Ship Yards," by Alexander Murray; "Oil Tight Work in Ships of Light Construction," by Herbert Rowell, Esq.; "Steam Yachts; Some Comparisons," by J. R. Barnett, Esq.

A revised chart in colors of Detroit river has just been issued by the United States lake survey office and is now for sale by the MARINE REVIEW.

C. & B. STEAMERS REMODELED.

The Cleveland & Buffalo Transit Co., better known among the traveling public as the "C. & B. Line," have always maintained the reputation of having at all times the "best in the world." This certainly applies to those two magnificent steel steamers, the City of Erie, the champion flyer of the lakes, and the City of Buffalo, the largest carrying capacity passenger steamer on the great lakes.

Last fall when these two modern monsters finished their season's work of traveling over 80,000 miles plying between their two ports, Cleveland and Buffalo, always on time, without the loss of a single life or accident of any kind, which can be truthfully said for the past twelve years of daily service, they deserved a much needed rest, and were placed in their slip for their annual three months' vacation. No sooner were they tied fast to their moorings than a large force of expert workmen were placed at work; designers, decorators, painters, carpenters, machinists, and marine engineers, thoroughly going over every foot of the vessels, painting, decorating, overhauling and remodeling and re-equipping the steamers from stem to stern in every department.

Probably the most interesting feature on ship board is to watch the officers and employes on each steamer in their weekly fire and inspection drill. This is given under the personal supervision of the captain of each steamer, ably assisted by his brother officers and crew to a man. They must be proficient and know their place, all employes of each vessel are trained to have special work and assigned to duty at given places, to act quickly and accurately at a signal of a bell. All life boats are manned with crews of each vessel, lowered over the side of each steamer into the water below. Life rafts, life preservers, fire hose, fire pails and fire extinguishers come into play, and are thoroughly tested by employes, so as to be acquainted and proficient in this line of work and place of duty in case of necessity. All life saving equipment, in fact everything and anything to save life or property is purchased from the manufacturers the best that money can buy. Numerous watertight compartments enter into the construction of these steamships, giving the greatest safety at all times, under any and every condition. All this equipment is thoroughly gone over in minute detail and passed by the United States government expert inspectors, who are more than strict as to material, manufacture, condition and regulations as to equipment and number.

Machinery and boilers are a most important factor. A main engine of 7,000 H. P. with fourteen auxiliary engines on each ship are thoroughly examined and tested by expert engineers and inspectors. All engines are taken apart piece by piece, rigidly inspected and replaced, making this part of the ship absolutely perfect. The boilers, six on each boat, are 12 x 12½ ft. They are carefully examined and rigidly inspected by United States inspectors with due regard for a great factor of safety. Two powerful electric plants of the latest make and improvement have been newly installed. These dynamos are certainly types of American beauties in workmanship to view and study. This new equipment was necessary on account of the increased number of electrical fixtures installed, making the lighting capacity of each steamer 2,500 lamps. The vessel is illuminated in every conceivable corner, and as the saying goes, they are as light as day.

Great care is exercised in the sanitary condition of each steamer. This is especially true of the crews' quarters where the men sleep. These rooms are regularly painted, new mattresses, blankets, linen, etc., provided each spring. The men are trained to study discipline, cleanliness and economy, and are held strictly accountable for anything to the contrary. The men of each department are also provided with a shower and spray bath next to their sleeping quarters. That this feature is appreciated by the employes of each boat is shown by the number of men who take advantage of this privilege, which is daily to a man.

An innovation on the part of the management of the line is the establishment of a special commission on each boat, consisting of the captain, chief engineer, purser, and steward, who hold weekly meetings on each steamer. Their duty is to thorougly inspect every quarter of the steamer in detail in reference to equipment, conditions, cleanliness, etc., which report goes to the general manager for his personal information.

During the winter considerable money has been spent in decorating both steamers. A few years ago Mr. Frank E. Kirby designed and superintended the construction of these beautiful ships and later performed the remarkable feat of lengthening the City of Buffalo 42 ft., thus largely increasing her capacity, strength, speed and economy in operation. Mr. Louis O. Keil's hand converted her interior into a veritable palace of dreamland. Now Mr. Keil has completely remodeled the interior of her sister ship, the City of Erie. If the beauty of the City of Buffalo excited general comment and delight, surely the City of Erie will show what a short period of time may accomplish in this age of amazing progress in arts and science. As one steps aboard the City of Buffalo and enters her dining room he finds himself suddenly transported to peaceful Holland, and rests his eyes on rare gems of exquisite art. In the newly remodeled City of Erie the traveler may feast his eyes on the glories that outrival the dazzling splendors of the days of Louis XIV and XV.

Entering the lobby, it will be found to be of an imposing size, having a length of about 50 ft. and extending nearly the whole width of the vessel. The decoration equipment and furniture has been particularly studied and is executed in Louis XIV. style. The walls are paneled in solid Cuban mahogany, adorned with panels in metal, decorated and glazed in deep rich green that blends into soft shades of yellow. A very pleasing contrast with the woodwork is thus obtained. Carved mahogany pilasters and capitals in gold support a ceiling of greenish buff paneling relieved with light tracery ornaments in gold, the whole giving a pleasing and harmonious effect. The furniture consists of heavy arm chairs upholstered in leather. Suspended from the ceiling, we find three electroliers in gilt bronze and of beautiful design.

Ascending the broad open stairway to the grand saloon, one is confronted by large mirrors, fine carvings and handsome paintings which adorn the stairway and landing leading to the gallery deck. The prevailing color of this deck is ivory with carved and relief work brought out solid in gold. The panels of the main ceiling, between the carlins are in shades of soft pearl coloring, ornamented in gold color in the Louis XV. design, interlaced and richly figured with flowers. Directly in the center of the ceiling are large panels with paintings of cupids floating listlessly through the maze of light, carrying ribbons and flowers. Each panel is a work of art in itself, and still in harmony with the general decorative scheme of the whole ceiling.

From the ceiling and walls, golden incandescents shed their soft lights over the entire saloon, illuminating it in royal splendor.

The entire woodwork of the grand saloon below the gallery deck is solid Spanish mahogany with decorated panels in relief, finished in gold and glaze. Against them are placed soft upholstered settees, covered with plush in old gold coloring, in exact harmony with decorative panels above them. They are arranged so as to group the passengers into small circles for convenient conversation. On the floors are spread the finest Wilton carpets of deep warm shades of green.

Bordering on the grand saloon are four parlors, two on either side, each of which is a room of exquisite splendor. They are in the Marie Antoinette design, and treated in four

different colors; rose, green, rich yellow and blue. The carpet covering the floor indicates the predominating color, and from it the colors blend up the paneled side walls, treated with festoons of flowers into the ceilings, where they are lost in panels of dainty paintings of flowers, ribbons and ornamental tracery. The stiles of wall panels, cornices and panel moldings of ceilings are in dainty ivory coloring enriched with gold. Arabian lace curtains hung from gold cornices cover the windows, between which is an elliptic mirror in a dainty gold frame. The furnishings consist of a brass bed, soft upholstered divans, small table and chairs. A bath room finished in white enamel is connected with each parlor.

The staterooms are furnished in pure white enamel with carpets and furnishings of a high order, and afford everything that can possibly be required for the comfort of the passengers.

Returning to the lobby, we enter the vestibule to the main dining room, which has been thoroughly remodeled. The ceiling is paneled in light ivory coloring with heavily carved laural moldings finished solid in gold. The walls are paneled in darker ivory shades with mirrors adorned in heavy carved frames, all finished in gold.

Special attention has been given to the designs of fixtures which are built in and form part of the decorations. They are finished in gilt bronze and bear globes of crystal beads which shed strong rays of light down upon the stairs leading to the main dining room. An exceptionally artistic and pleasing effect has here been produced by the skillful employment of design and color. The dining room of the sister ship, City of Buffalo, is designed in the Flemish renaissance, while this room is designed in the French renaissance, making a complete change from the other. At the foot and at either side of the stairs are massive carved candelabra finished in metal and verde antique. The main ceiling is pure white enamel paneled and decorated in gold tracery design, supported by two rows of Sienna marble columns with capitals in metal and verde antique. A row of side boards with doors artistically paneled in malachite green oak, extends the entire length on either side of the room. These sideboards are in strict keeping with the wainscoating with which they combine. Directly above the side boards, we find the walls spaced out in very attractive panels with brackets supporting the ceiling. The ground work of the walls is in pure white enamel ornamented in gold relief and keeping with the ceiling. Looking forward and directly in the center of the room is the main sideboard which is about ten feet long and furnished in malachite green oak. The upper section consists of cabinets lined with mirrors for silver and cut glassware, over which are carved grills of French design finished in metal and verde antique. At either side of the sideboard are the private dining rooms, the crowning glory of the magnificent room. These rooms are also of a French renaissance design, the ceilings being paneled and supported by heavy beams in green oak. The side walls are paneled in oak, relieved by mirrors and panels of bright crimson silk brocade. Cabinets lined with mirror backs and extending from floor to ceiling are built in each corner. The openings looking out into the main dining room are provided with heavy carved candelabra, the design and finish of which are in keeping with those at foot of stairs. Each of these rooms contain a circular table, surrounded by eight chairs of a French design, finished in malachite green, upholstered in crimson Spanish leather and studded with dull brass nails. Over the center of each table are suspended dome fixtures in dull metal, verde antique, with crimson silk shades in perfect keeping with the brocade wall panels. Main dining room is about forty by sixty feet in size.

Returning to the main dining room and looking aft, we find on either side of the stairway rooms conveniently arranged with shelving for hats and cloaks. Here, too, much splendor prevails. The openings into these rooms are hung with heavy portiers of deep shades of green crinkle silk with borders of heavy metal applique. At either side of these openings are heavily carved open wall cabinets finished in metal and verde antique.

They are arranged with mirror backs and shelving for rare pieces of decorated china and pottery. The floor is in tile design of green and white, with marble base extending around the entire room.

The chairs and tables are also of French design, finished in malachite green oak and in keeping with the room. They are upholstered in yellow Spanish leather and studded with nails to match. Suspending from the main ceiling are thirty incandescents of special design with crystal bead globes, which throw a glow of light upon the tables.

The buffet is directly aft of the main dining room and is entered by a stairway leading from the main deck. Here, too, very artistic effects have been gained. The ceiling and wall panels are in shades of old ivory ornamented in strong coloring of a heraldic design. On either side are large settees built in recesses with deep rich mahogany panelings luxuriously upholstered in soft green leather. At the forward end and directly in the center of the room is a large buffet carved in mahogany, with large mirror back in carved metal frame. The floor is in a mosaic design with marble base, extending around the entire room. No money, skill or talent have been spared in making this swift ship one of the most beautiful on the lakes.

All this is but a part of this winter's work and expenditure. Special attention has been given to the more vital parts of both steamers. In the captain's department particular attention has been given to the general condition of the steamers, perfection of all life saving apparatus, in fact everything has been done to make that department perfect.

The engineer's department, the main propelling engines being of 7,000 H. P., with fourteen auxilliary engines, have all been taken apart piece by piece and replaced in faultless condition. The paddle wheels, measuring 30 ft. 6 in. in diameter and weighing 58 tons each, have received the same scrupulous attention. New and modern dynamos have been installed in order to provide sufficient light for the new order of things. A new feature that will be fully appreciated by the crews is numerous shower baths for each and every member of the crew from the highest to the lowest.

It is expected these steamers will go into commission about April 10, from which date they will run daily between Cleveland and Buffalo until Dec. 1.

THE BOOK OF BOATS.

The "Book of Boats" is a brief story by Raymond Cavanagh of some of the queer prototypes of the modern launch with drawings by E. P. Seidel. The author traces the devolopment of the small boat from the beginning and gives considerable information about dug outs, proas, sampans, outriggers and the various water craft of savage and semi-savage races. Each type is illustrated. He concludes with a chapter on the power launch illustrated with designs by the Truscott Boat Mfg. Co., St. Joseph, Mich. The book is printed by the Randall Printing Co., St. Paul, Minn., and is well worth getting. Price 50 cents. For sale by the MARINE REVIEW.

The Chicago members of the Tug Firemen & Linesmen Protective Association that are employed by the Great Lakes Towing Co., have demanded an increase in wages and every other night and every other Sunday off. The increase demand amounts to $5 per month. The demand for every other night and every other Sunday off was the cause of the big strike five years ago, when the tugs were tied up the greater part of the season.

THE DYNAMICS OF SCREW PROPELLERS.

BY PROFESSOR ROBERT H. SMITH.

The subject of screw propellers seems to provide perennial entertainment to engineers outside the classes who have perforce to design, to make, and to use them. To these latter classes they are continuously a cause of perplexity, astonishment, vexation, and disappointment.

The only excuse offered for the present incursion into this vortex of confused discussion is that the intention is to conclude with a suggestion of actual constructional improvement. Whether this suggestion will be of practical value it will be for the naval architects and marine engineers to decide. It appears, at any rate, that the suggestion is new, or, if not novel, must be a revival of a proposal that has not hitherto had a fair hearing and has never been fairly put to the test.

Some amateur students of hydrodynamics err very greatly in forgetting that the equation $p + \frac{1}{2} \rho v^2 =$ constant does not represent any true law outside the limits of a steady stream flowing in a channel with fixed walls; that is, with walls which can neither do any work nor have any work done on them. If the walls do work on the flowing fluid that work has to be added—per proper unit of volume and of time or length of channel or other unit considered in the progress of the action—to the constant on the right-hand side. As it stands unmodified, the equation is the hydrodynamic law of a conservative system, that is, of a space whose total energy is neither increasing nor decreasing by integral influx or outflow of energy. The lamentable way in which automatic engineers forget the real physical meanings of their formulas is well illustrated by the fact that the sole popular engineering application of this formula is to the case of flow through frictional channels in which energy is being steadily developed by loss of gravitation potential, and at the same time steadily spent in doing work on the friction of the walls. For this case the formula is, of course, modified so as to give correct results; yet the letters published in *The Engineer* show that many of the writers would like to apply it to working hydrodynamic machines without any modification at all. "Hippocrate dira ce qu'il plaira—mais le cocher est mort;" doctors may flourish equations which they do not understand as much as they please—but the trust law of conservation will stop the machine if it goes on working without being fed with new energy.

In the issue of May 26, Mr. J. Batey, infers from Rankine's declaration of 1865 that "the best propeller is one that drives the least water astern at the lowest velocity," that the "perfect screw drives no water astern and therefore with no velocity." Passing over the embarrassing substitution of "least" for "greatest," which is probably accidental on Mr. Batey's part, could any inference be more astonishing? The ship's resistance is prescribed and it equals M S so that M S can only vary inversely to each other; if S be diminished, M must be proportionately increased. But the kinetic energy involved in this momentum is

$$\frac{1}{2} \text{ M S}^2 = \frac{(\text{M S})^2}{2\text{M}} = \frac{\text{Prescribed constant}}{\text{M}};$$

and the only way to reduce this loss is to increase M.

Here it is interesting to note that Rankine's paper in *The Engineer* of November, 1866, as quoted in this issue of August 4 of this year, just doubles this kinetic loss. The error is probably due to the fact that people had then hardly got out of the old fashion of measuring the energy of motion by vis viva, or MS^2, intead of by $\frac{1}{2}\text{ MS}^2$, which is the true kinetic energy.

It is worth putting down the calculation for the sake of a very simple graphic construction for the efficiency which the writer has not seen given elsewhere.

Equation I.—

R = prescribed ship resistance = necessary direct propelling force = repelled mass per second × new backward velocity of this mass = M S = ρ A (V + S) S,

where ρ = mass per unit volume of water, A = cross-sectional area through which the repelled steam passes, and V = speed of ship, and M the mass repelled per second with the newly impressed sternward velocity S.

It should here be carefully noted that there is involved in this the assumption that the water which is taken through the propelling machine has zero fore or aft velocity before its entrance into the machine. This does not at all mean that it retains such zero velocity until it reaches and actually touches the propeller blades, or comes under their direct impulsive influence.

It means that the ship is steaming through quiet water; or that, if its progress is against, or along with, a current, everything is measured relatively to that current—both momentum and velocity of kinetic energy. V is the speed of the ship through the current, measured relatively to the water of the current and not relatively to the earth. But the new velocity S may be acquired long before the water repelled by the propeller-blades actually reaches these blades. To illustrate from the analogy of a fan or of a centrifugal pump, suppose that the "suction" and "delivery" pipes are of the same area; then evidently there is the same velocity of passage through these two pipes. [In the case of the fan there is a small rise of pressure, and therefore of density, and a corresponding small decrease of velocity in passing from suction to equal-sectioned delivery, but the change is so small as not to affect the question materially.] The velocity of delivery has been wholly acquired before arrival at the blades of the pump. It is acquired through the down-grade of pressure from the atmospheric pressure of the reservoir (plus or minus any water head in the suction-pipe) to the partial vacuum pressure maintained behind the fan or pump blades by the dynamic action of these blades. The work of acceleration up to this intake velocity is directly done by the atmosphere which pushes the air or water into this vacuum; but it is eventually done by the fan or pump which has to do the same amount of work upon the atmosphere at the other end of the circuit, i. e., at the far end of the delivery. This is the scientific answer to the inquiry as to "Elusion of Instantaneous Acceleration" made in the leading article in *The Engineer* of March 24. As pointed out in that article, no instantaneous integral acceleration occurs in any of these machines, fans, pumps, or propellers, nor indeed in any place in nature. So far as principle and general outline of action are concerned, there is no mystery whatever about the matter. The same accelerative work is done in the same way in the suction or supply part of every pumping machine, whether of the piston, rotative, induced jet, or any other type. There may be in many cases considerable obscurity as to the exact shape and varying sections of the stream lines along which this acceleration in the supply occurs. For instance, what practical or mathematical engineer has ever been able to work out the stream lines of the passage past the multitudinous forms of supply and delivery valves in use or through the ports and bends whose shapes vary only in the degree of their utter badness from the point of view of hydrodynamic efficiency? All that we do know certainly is that the lines of these valves and ports are commonly designed without any reference to the shapes, good or bad, of the fluid stream lines that they compel. Until the actual stream lines throughout the length of the

intake can be definitely determined, it is impossible to see how exactly the acceleration up to the final inlet velocity is distributed. The precise mode of action from point to point remains obscure. But if by measurement we discover the actual pressure at entrance just before reaching the propelling blades, then with a speculative allowance for frictional and viscosity losses, we can calculate this entrance velocity.

Be it observed, however, that this entrance velocity produced by the lost head down to the entrance pressure is not necessarily in the direction of the useful working effort of the propelling blades. Practically it can never be so in any form of rotating pump, any more than it is so in a turbine. In the case of a ship propeller, it is certainly not axial, and its amount, therefore, is no direct indication of that of the direct axial discharge velocity S. Clearly, its magnitude may be many times that of S.

For a prescribed ship resistance R and a specified cross-axial section A of the repelled stream, Equation I is a quadratic for the calculation of the discharge speed S. There are two mathematical solutions, but one only has application to the ship problem: it is

Equation II.—

$$S = \frac{V}{2} \left\{ \sqrt{1 + \frac{4R}{\rho A V^2}} - 1 \right\}$$

from which the mass repelled per second may, if desired, be calculated as $M = \frac{R}{S}$.

From this Equation II it is apparent that so long as the ship resistance R remains in the same proportion to V^2, the axial discharge velocity S varies in constant proportion to V, the speed of the ship. If R increases more slowly than V^2, S increases more slowly than V; and if R increases more rapidly than V^2, the required S increases more rapidly than the speed. If throughout any range of speed R remains constant, as is nearly the case for a considerable range beyond the "critical speed" in Mr. Yarrow's recent interesting trials, then S diminishes with increase of V throughout that range. [This is easily proved by taking the differential coefficient of S with respect to V.]

The rate at which work is done usefully in propelling the ship is $R V = M S V$, and the rate at which kinetic energy is generated in repelling the mass M per second backward is $\frac{1}{2} M S^2$, calculating only from the necessary axial component of the "delivery" velocity. The ratio $\frac{1}{2} M S^2 \div S V = \frac{1}{2} S \div V$ is the minimum ideal inefficiency inseparable from the method of driving ships forward by thrusting backwards on the water. It yields the following measure of the

Equation III.—

$$\text{Ideal maximum efficiency} = \frac{4}{3 + \sqrt{1 + \frac{4R}{\rho A V^2}}}$$

This may be represented graphically by the very simple diagram above. With a common center two opposite circular quadrants are drawn with radii equal to 1 and 2. Along a tangent to the smaller quadrant is plotted from the touching point $\frac{2}{V} \sqrt{\frac{R}{\rho A}}$.

From the point s, obtained by this plotting, a line is drawn through the center cutting the two arcs in e and E. Then the efficiency of Equation III is $\frac{E e}{E s}$. The height plotted to s is proportional to $\sqrt{\frac{R}{V^2}}$ and so long as R varies at V^2 this efficiency remains the same. The plotted height is inversely proportional to $\sqrt{A}$, and the diagram exhibits very graphically in what manner this efficiency is increased by increasing A, or the cross-axial section of the repelled stream of water. For any one shape of the section, such as the circular, $\sqrt{A}$ is, of course, proportional to its diameter or other lineal cross dimension.

It is not possible to assert that this calculation has any extremely near practical importance. The whole of the discussion in *The Engineer* this year has been devoted to the question—how does the propeller drive the ship? But the really difficult, mysterious, and extremely important question is how does the propeller waste energy without driving the ship? Calculations made by the writer show that in many cases more than 50 per cent of the actually indicated engine power cannot be accounted for by the sum of engine and thrust block friction plus skin and wave resistance of the ship. The late Mr. Froude said that no more than 40 per cent of the power was commonly spent in usefully overcoming the ship resistance.

The question of what becomes of the rest is of immense importance, because if it could be saved, a saving of at least 30 per cent of fuel and coal bunker capacity would be possible. Only a small proportion of this loss is accounted for by the above $\frac{1}{2} M S^2$. If Rankine's slip of the pen in putting this down as $M S^2$ has had any real effect in making marine engineers imagine that their propelling machines have any efficiency worth speaking about, that would be greatly to be regretted.

"Superintendent Engineer" speaks very positively about the actual existence of what he implies is a very large value of S. Although cavitation, or partial vacuum, on the forward surfaces of the propeller blades almost certainly exists in greater or less degree under all circumstances, this does not in the least supersede the necessity of the M S as an abutment thrust. The simplest way of viewing that point seems to be to remember that this cavitation vacuum exists between the propeller and the stern hulk of the vessel, and whatever advantage might apparently be derived from the lack of sternward pressure on the front surfaces of the propeller blades is lost by the equal lack of forward pressure on the stern bulk of the ship.

It is possible that this vacuum may die away even in the narrow space between the two in an upgrade of pressure towards the hulk; from the probable curvature of the water stream lines here some upgrade of pressure, although a small one, very likely exists here. But this would hardly affect the matter, because the water close to the hulk would in that case be practically dead water to be carried and driven along with the ship as if it were itself part of the hulk. The actual magnitude of S is not, however, directly proved to be great. "Superintendent Engineer" asks us to observe the immense back flow of water easily visible when a ship is moored fast and its paddles or propellers rotating; but this observation is quite irrelevant. The present writer has spent a great many hours in watching the progress of the flotsam both inside and outside the apparent limits of the wake-stream, from the propeller in ocean and Channel steamers, and, although there was usually clear evidence on the surface of a real backward S, yet this was not always so, and the apparent magnitude of S was never large. Of course, the relative speed at which such flotsam recedes from the vessel is great, but that is $(V + S)$. It is also to be remembered that one can only observe the surface water, and it is probable that the backward under-current is much greater than on the surface.

It is clear that the action of the propeller must to a very considerable extent modify the stream lines around

the ship, and thus influence the wave resistance, and to a smaller degree the skin resistance of the ship. It is conceivable that under certain conditions it might lessen this resistance; but the normal result of the propeller disturbance seems probably an increase of it. Is it not regrettable that the intake of water from round about the stern hulk into the propeller should be left absolutely without any guidance of any kind? Such lack of guidance at entrance into the working machine must inevitably result in unnecessary eddy-making, and also in the arrival of the water at the blade edges in directions deviating from the most economic proportions. What may be termed the inside surface of the intake channel is the stern of the hulk; but its lines are designed mostly without reference to true guidance into the working machine: they are modeled on the lines found to give least hulk resistance when the ship is towed at the bow and is unhampered by obstructions such as a propeller at the stern. The outside of this intake channel has no prescribed boundary. In no other hydraulic machine in existence is the inlet channel left so completely to form itself at its own sweet will, or in obedience to "natural laws" in contradistinction to artificial restraint. The essence of all good machines is to artificially restrain the motions of its parts along most economic lines, and this fundamental law of machine construction is completely neglected in ship propulsion by screw propellers.

What are the best guiding lines up to the front edges of a screw propeller is a difficult problem of design far beyond the scope of this article. It is one which the writer hopes may engage the attention of marine experts in future years, but which will not be settled by a single theoretical investigation nor by a single experimental research.

The delivery side of the machine is equally without guidance. It would be hard to say if this results in greater loss than the want of inlet guidance. What is certain is that the loss must be immense. The most elementary mechanical consideration of the thus unguided propulsive action of the screw blades shows that the velocity of delivery must have a large component that is not axial; and the first half hour of observation over the stern of an ocean steamer shows anyone, with eyes in his head, that this is the actual result. The whole of this transverse component of discharge velocity represents pure unnecessary waste of kinetic energy. If the angle which the discharge velocity makes with the axis be called δ, then the kinetic energy thrown away in the wake-race is increased from the necessary $\frac{1}{2}$ M S^2 in the ratio $(1 + \tan^2 \delta)$. If δ be 45 deg., it is doubled; if δ be 60 deg., it is quadrupled; if δ be 75 deg., it is multiplied 14-fold. If S, T and C be the axial, tangential, and centrifugal components of this discharge velocity, then the kinetic energy abandoned in this discharge is greater than that essentially necessary in the ratio—

$$\left(1 + \frac{T^2 + C^2}{S^2}\right),$$

whereas the useful propulsive thrust remains proportional to S only.

Suppose that it were found to be desirable for the mechanical efficiency of the machine as a mere driver of water that the discharge at the delivery tips of the blades should have these components in the proportions S, T, and C, then if this discharge were received into properly designed fixed guide channels which deflected the whole velocity $\sqrt{S^2 \times T^2 \times C^2}$ into the backward axial direction, then the useful propulsive effort would be proportional to this whole velocity, instead of simply to S alone. That is, you can reduce your expenditure of kinetic energy in the wake to the scientifically essential proportion, and yet discharge your water from the delivery tips of the blades at any radial and tangential angles you may find desirable for the good working of the machine, if you will only discharge into a fair-lined exit channel deflecting the whole into parallelism with the path of the ship's motion.

So far as the writer of this article has studied the problem, it would not be possible, with screws as commonly designed, to get the desired propulsive effect without the blades imposing upon the water a tangential velocity. It may not be wholly imposed on it by direct contact during their passage; it may be partially, or even under possible conditions wholly, imposed indirectly during approach to the blades along the supply stream lines. But it would be silly to suppose that the water at any instant in contact with any part of the blade surfaces, front or back, had any relative velocity normal to the blade. The whole relative velocity of the water actually touching must be parallel to the blade surface, and that of water passing near the surface must be more or less approximately parallel to it. The "absolute" motion of the blade is at every point along a helical path with velocity prescribed by V and the revolutions per minute, and the absolute velocity of the water equals this compounded with a velocity parallel to the blade. This relative velocity may under certain critical conditions be zero on either surface, back or front; that is, there may be masses of dead water carried round adhering, so to speak, to either back or front of the blade. Under other critical conditions of speed the tangential component of relative water velocity may just counterbalance the tangential component of absolute blade velocity. But away from such special and critical conditions, there must be tangential velocity, along with which must be generated centrifugal acceleration. This sets up outward radial currents, or radial components of velocity. The general direction of relative flow over the sternward faces of the blades is from near the boss at the forward edges towards the tips at the back edges. The chief supply streams must enter along the inner or more central parts of the cutting edges, little, or perhaps no, supply entering near the outer tips. Thus along the approach stream lines there is inward radial component of motion, and along the back surface of the blades outward radial components. Beyond certain critical rotative speeds coordinate with the corresponding traveling speed, these tangential and radial components of velocity must increase rapidly with the speed; and the critical speeds are probably low in all common forms of screw propellers.

It is in the abysmal depths of the vortices so arising that, according to the belief of the writer, are swallowed up the enormous losses of energy that are known to occur, but which have never been measured or calculated. The vortices are probably quite unavoidable, but their kinetic energy may be recovered and utilized by improved design.

It may be utilized in either of two ways:—(1) By deviation, as already suggested, of the flow from the direction in which it leaves the blade-edges, into parallelism with the axis; and (2), along with (1), by diminution of the magnitude of the velocity after it has left the blades by discharge through a channel of tapering section. This second method leaves not only the direction but also the velocity-magnitude of the discharge from the blades to the free choice of the designer of the propeller and of the engine. As in the evase discharge from a high-lift centrifugal pump, the high velocity and kinetic energy of discharge from the moving machine is converted into pressure energy or "head." The M S as it leaves the propeller blades is insufficient to provide the desired R, or propulsive effort, needed for the speed of the ship; but the forward pressure on the walls of the fixed evase dis-

charge tube due to the extra pressure created by the widening section and the consequent diminution of velocity and of kinetic energy, makes up the deficiency in R, and gives the prescribed R with less kinetic expenditure in the final $\frac{1}{2}$ M S^2.

We have now arrived at the idea of a propeller with guided inlet channel and guided exit channel for the water. The guidance will be the more complete by the insertion of guide-blades between the walls of the guiding channels. The whole machine has become an enclosed one, and its various parts, fixed guides and working blades, are capable of as strictly scientific design as are those of a high-class turbine, or of a Reynolds-Mather or a Sulzer high-lift centrifugal pump. The water is everywhere artificially constrained to follow the paths of mechanical efficiency; it is no longer violently tossed and swirled at the mercy of the wild tyranny of the free ocean. In a word, the propeller becomes a civilized machine, and drops its character of a barbaric warrior fighting rudely and blindly with Nature's stormy forces.

But, finally, now that the propeller machine is enclosed in a casing rigid with the ship's hull, there is evidently no reason why it should remain outside the fair lines of the skin of that hull designed to minimize ship resistance in accordance with the laws established gradually by nearly a century of practical trials and theoretical and experimental research. Outside these fair lines it is certainly a great disturber of the economic stream lines, to procure which is the sole object of the design of these lines. If withdrawn inside the hull its intake and its discharge must still be reckoned with as greatly influencing these stream lines; but its body, at least, is no longer an obstruction. If this body be taken inside, there are at once removed practically all restrictions as to the design of that body. The problem of its design becomes simply that of producing the most efficient high-pressure pump to produce specified results under the conditions of greatly varying load and greatly varying traveling speed of ship.

This leads us back ultimately to the idea of the jet-propeller, and it may be said that this idea has long since been tried and failed; also that the experiment of the propeller set in a fore-and-aft tunnel along the keel of the ship has been tried and failed.

But there may be little hesitation in declaring that these systems were never subjected to fair trial; that there was no persistence in trying improved forms after the failure of the first designs. Rankine said nothing against jet-propellers except that Ruthven's was inefficient because of the evident fault, pointed out by Rankine, that the areas of the jets were, in an extremely large ratio, too small. Because two or three small jets necessarily throwing into the wake an excessive quantity of axially-directed kinetic energy were a failure, it hardly follows that the same system otherwise designed must necessarily be bad. The first Laval steam turbine was not a success, and the first Parsons turbine was a still greater failure. The component of discharge velocity represents pure unsuccess of a jet system, especially in view of its influence upon the skin and wave resistance of the ship, must greatly depend upon the design of the intake—upon its form and upon its position, upon whether one, two, or a dozen intake ports are used, and upon the distribution of a multiple system of ports. By the light of past experience, one is almost tempted to say that it would have been easy to predict that two, or even three, repelled jets could hardly result in efficient working, and that twelve or sixteen skilfully distributed over the cross section of a bluff stern at such spacings and so disposed as to enable them to carry backwards with them induced currents of water not passed through the inside propelling pump would more likely satisfy the general conditions of economy. For example, an elementary examination of Equation II, shows how great would be the advantage of being able to increase A along with the traveling speed V, a control easily effected by opening more or fewer of the valves to the different jet-tubes or groups of these, according to varying conditions of speed, head wind, etc. With a single, or even a duplex, intake placed far forward, the steering qualities of the vessel are naturally much interfered with, as experience proved if memory serves aright; but with a multiple intake, with the ports scientifically placed and distributed and controlled by a series of valves equal in number to the ports or proper groups of ports, the stoppage or reversal of the flow through one or several groups of intake ports and stern jets would provide a graduated and powerful method of steering in substitution of, or in reinforcement of, the rudder steering.

The elementary advantages of jet-propulsion have often been discussed, and the object of this paper is not to go over again old ground, although mention should be made of the incidental gain in passing through the hold an enormous flow which may be used as condensation water. The object of the paper is to urge that the scientific mechanics of ship propulsion clearly points towards some form of jet-propulsion, and that different forms of this mode of propulsion have never been sufficiently experimented upon. Steam turbines, combined with high-lift compound centrifugal pumps and multiple intakes and stern jets skilfully distributed in groups, seems to be a solution of the problem of economic propulsion well worth working at.

The Lozier Motor Co. have received an interesting report from their agent in Auckland, New Zealand, describing the races which were held at Auckland on Jan. 29. There were only two events open to cruising boats, but both of these events were won by Lozier engines. The first race was for cruisers making under seven knots and was won by the Esma, a boat 22 ft. by 5 ft. 6 in., equipped with a 3-H. P. Lozier. In the race for cruisers making over seven knots the winning boat was the Ikatero, 30 ft. by 5 ft. 8 in., equipped with a 7½-H. P. motor. The Ikatero is evidently an unusually fast boat for in the previous regatta at Mahurange on Jan. 13, she won both races, this being the third time she has started and being the winner each time.

The R. M. Spedden Ship Building Co., Baltimore, Md., launched the steel tug Robert H. Smith recently. This tug is 118 ft. long, 23 ft. beam and 13 ft. 3 in. deep, and will draw about 10 ft. of water. Her engines will be fore and aft surface-condensing compound type, with cylinders 16 and 32-in. diameters by 24-in. stroke. Steam will be supplied from a boiler 12 ft. 6 in. diameter and 11 ft. 6 in. long.

Representative J. P. Jones has introduced a bill in the house of representatives requiring all sea-going and lake vessels to carry a quantity of oil with apparatus for its distribution on the water in time of storm. The use of oil on water is well known and it is surprising that more advantage is not taken of it.

Three bids were received for building the new harbor boat for the city of St. Louis, the Howard's Ship Yard Co., Jeffersonville, Ind., bidding $59,858, the Springfield Boiler & Manufacturing Co., Springfield, Ill., $59,695, and the Dubuque Boat & Boiler Works Co., Dubuque, Iowa, $61,175.

The steamer Hendrick Hudson, building at the yard of the T. S. Marvel Ship Building Co., Newburg, for the Hudson river day line, will be launched on March 31.

NEW TEST OF DIXON'S FLAKE GRAPHITE.

The following test of Dixon's flake graphite made by Prof. Soss, of Purdue University, demonstrating its value as a lubricant and its mechanical affinity for metal surfaces is of much interest.

The Lubricating Mixture.—In considering the manner in which the graphite under test should be applied in lubricating the rubbing surfaces of the testing machine, it was deemed desirable to use as light an oil as was available, since by so doing but little lubricating effect would be realized from the vehicle and the maximum service would be secured from the graphite. An attempt to use water proved unsatisfactory because of the tendency of the rubbing surfaces to corrode under its influence, and kerosene was finally adopted as the most convenient and most satisfactory vehicle. Throughout the test the lubricant employed has been either kerosene, or mixtures of kerosene and Dixon's flake graphite.

Kerosene as a Lubricant.—Before attempting any work with graphite the value of the vehicle was first determined. That this might be done, the machine was operated under kerosene lubrication for a considerable period, the pressure between the rubbing surfaces being gradually increased as they became more worn in service, the effect of the process upon the co-efficient of friction being noted. This process of wearing down rubbing surfaces in the presence of kerosene involved more than 600,000 revolutions of the test machine. The heaviest pressure that could be sustained by the rubbing surfaces under this lubrication was 50 lbs. per square inch of surface, and the lowest co-efficient of friction developed was .00547. This record was accepted as representing the performance of kerosene as a lubricant.

After the 633,287 revolutions involved by the process described in the preceding paragraph, a mixture, by weight, of two parts kerosene and one part Dixon's flake graphite was made. This mixture had the consistency of thin paste when stirred, but the flakes of graphite quickly settled when permitted to stand at rest. The immediate effect of applying this mixture as a lubricant was to increase the co-efficient of friction, but this in its maximum effect was momentary. Without change or any modification of the lubricating mixture, the co-efficient of friction rapidly fell, first to the value given by the kerosene alone, and then to still lower limits, so that after 10,000 revolutions, occupying a period of something less than thirty minutes, the co-efficient of friction, under the influence of the mixture of kerosene and Dixon's flake graphite became 83.9 per cent of that obtained from the use of kerosene alone. Conditions thus secured were continued during more than 400,000 revolutions of the test machine, for the purpose of determining beyond doubt the minimum co-efficient of friction under the conditions stated, subsequently the pressure between the rubbing surfaces was increased by increments of 10 lbs., until a maximum of 110 lbs. per square inch had been secured. Beyond this limit lubrication failed. The observations show that as the pressure was increased, the co-efficient of friction diminished, the minimum value being .00296. The immediate effect, therefore, of adding Dixon's flake graphite to the kerosene was, first, to permit an increase of load from 50 lbs. per square inch to 110 lbs. per square inch, that is, an increase of 120 per cent; and, second, a reduction in the co-efficient of friction from .00547 to .00296, that is, a reduction of 45.9 per cent.

Endurance of Flake Graphite.—Having secured these results, it was next sought to ascertain the endurance of the graphite as a lubricant. This was done by removing all graphite from the machine and by rinsing all parts involved, including the rubbing surfaces, with kerosene, after which the machine was operated under a pressure of 100 lbs. per square inch in the presence of kerosene alone. Under these conditions, the lubrication was aided by such particles of flake graphite as naturally adhered to the rubbing surfaces. It was expected, however, that these particles of flake graphite would sooner or later disappear and that the conditions would return to those originally found for the kerosene alone. Each morning the rubbing surfaces were removed from the machine and all parts carefully rinsed for any particles of graphite, and the work of the day proceeded, usually to the extent of 150,000 revolutions. After eight days' running and 978,000 revolutions, no diminution in effect could be discovered. Both the capacity of the bearing and the co-efficient of friction developed remained unchanged. A microscopic inspection of the surfaces showed the presence of flake graphite upon them. Whether the amount was sufficient to account for the results obtained, or whether in the earlier stages the presence of the graphite served to control the finishing of the metallic surfaces to permit them to give highly satisfactory results, are questions which can not be determined. The probability is, however, that without the graphite the results would not have been secured.

PROPOSED NEW DRY DOCK AT NEW ORLEANS.

New Orleans, La., April 4.—An era of dock-building has apparently taken New Orleans by storm, evidences of this being furnished in the recent announcements that certain new docks were to be constructed and operated here within a very short time. In this connection it might be mentioned that Moses Schwartz, a member of the firm which operates Schwartz's big foundry here, and a number of his associates, among whom are Boston and New York capitalists, as well as New Orleans people, had purchased the property of the McLellan Dock Co., at McLellanville, just below New Orleans, and would within the near future build a dock of 8,000 or 9,000 tons capacity, to be located at McLellanville, In addition to this the new company will build machine shops and wharves, thus thoroughly equipping a plant which will be able to handle all kinds of marine repair work. It was stated some days ago by Mr. Schwartz that his company would expend about $200,000 on its big dock. The deal between Mr. Schwartz and his associates and the McLellan interests was consummated several days ago, when all the property of the latter was turned over to the former.

While the new company is waiting for the plans for its big dock to be prepared it will operate the docks which were operated by the McLellans and which are now in use. These are the Ocean and the Marine docks, but neither is capable of handling a very large ship. Both, too, are somewhat out of date and should be replaced by newer and better structures.

The house committee on naval affairs has practically decided to report a building program for new ships for the navy as follows: One battleship, to cost, exclusive of armor and armament, $6,000,000, the ship to be of the largest type; three torpedo boat destroyers to cost $750,000 each; and $1,000,000 to be expended by the secretary of the navy for submarine boats at his discretion. The naval bill will carry a total of about $100,000,000.

The fire that destroyed the fine steamer Plymouth, of the Fall River Line, also did considerable damage to the steamer City of Lowell and the wharves at Newport. It was only by prompt action that the steamers Priscilla, Puritan and Nantucket were saved. The Plymouth was built at Roach's, Chester, Pa., at a cost of $1,500,000 in 1890.

Buyers' Directory of the Marine Trade

For a more complete classification than that represented by advertisers in the Marine Review, see the BLUE BOOK OF AMERICAN SHIPPING, marine and naval directory of the United States, published by The Marine Review, Cleveland.

See accompanying index of Advertisers for full addresses of concerns in this directory.

AIR COMPRESSORS, AIR HOISTS, ETC.
Great Lakes Engineering Works......Detroit.
Mietz, Aug. ....New York.

AIR PORTS, DEAD LIGHTS, ETC.
Marine Mfg. & Supply Co.........New York.

AIR PUMPS AND APPLIANCES.
Fore River Ship & Engine Co..Quincy, Mass.
Great Lakes Engineering Works......Detroit.

ANCHORS.
Bowers, L. M. & Co.......Binghamton, N. Y.

ANTI-FRICTION METALS.
Cramp, Wm. & Sons............Philadelphia.

ARTIFICIAL DRAFT FOR BOILERS.
American Ship Building Co.........Cleveland.
Detroit Ship Building Co.............Detroit
Great Lakes Engineering Works......Detroit

ASH EJECTORS.
Great Lakes Engineering Works......Detroit.

ATTORNEYS AND PROCTORS IN ADMIRALTY.
Gilchrist, Albert J................Cleveland.
Goulder, Holding & Masten........Cleveland.
Hoyt, Dustin & Kelley............Cleveland.
Jenkins, Russell & Eichelberger....Cleveland.
Kremer, C. E.......................Chicago.
MacDonald, Ray G...................Chicago.
Shaw, Warren, Cady & Oakes........Detroit.
White, Johnson, McCaslin & Cannon Cleveland

BAROMETERS, MARINE GLASSES, ETC.
Ritchie, E. S. & Sons.......Brookline, Mass.

BELTING (LEATHER).
Republic Belting & Supply Co......Cleveland.

BLOCKS, SHEAVES, ETC.
Boston & Lockport Block Co.....Boston, Mass.
Cleveland Block Co................Cleveland.

BOAT BUILDERS.
Drein, Thos. & Son.........Wilmington, Del.
Kahnweiler's Sons, David.........New York.
Marine Construction & D. D. Co..........
..........Mariner's Harbor, S. I., N. Y.
Truscott Boat Mfg. Co.....St. Joseph, Mich.
Willard, Chas. P. & Co. Winthrop Harbor, Ill.

BOILER COMPOUNDS.
The Bird-Archer Co............. .. New York
Dearborn Drug & Chemical Works....Chicago.
State Manufacturing Co...............Cleveland.

BOILER MANUFACTURERS.
Almy Water Tube Boiler Co..Providence, R. I.
American Ship Building Co.........Cleveland.
Atlantic Works..........East Boston, Mass.
Chicago Ship Building Co...........Chicago.
Cramp, Wm. & Sons...........Philadelphia.
Dearing Water Tube Boiler Co........Detroit.
Detroit Ship Building Co.............Detroit.
East End Boiler Works..............Detroit.
Fletcher, W. A. & Co.........Hoboken, N. J.
Fore River Shipbuilding Co.....Quincy, Mass.
Great Lakes Engineering Works......Detroit.
Kingsford Foundry & Machine Works....
..........................Oswego, N. Y.
Maryland Steel Co.......Sparrows Point, Md.
Milwaukee Dry Dock Co..........Milwaukee.

BOILER MANUFACTURERS—Continued.
Mosher Water Tube Boiler Co....New York.
Newport News Ship Building Co.........
.....................Newport News, Va.
New York Shipbuilding Co.....Camden, N. J.
Northwestern Steam Boiler & Mfg. Co....
..........................Duluth, Minn.
Quintard Iron Works Co...........New York.
Roberts Safety Water Tube Boiler Co....
..............................New York.
Superior Ship Building Co.....Superior, Wis.
Taylor Water Tube Boiler Co........Detroit.

BOILER RIVETS.
Bourne-Fuller Co.................Cleveland.

BOILER STAYBOLTS, IRON OR STEEL, HOLLOW OR SOLID.
Falls Hollow Staybolt Co..Cuyahoga Falls, O.

BRASS AND BRONZE CASTINGS.
Cramp, Wm. & Sons............Philadelphia.
Fore River Ship & Engine Co..Quincy, Mass.
Great Lakes Engineering Works......Detroit.
Lunkenheimer Co.................Cincinnati.

BRIDGES, BUILDERS OF.
Scherzer Rolling Lift Bridge Co.....Chicago.

BUCKETS, ORE AND COAL.
Brown Hoisting & Conveying Machine Co.
.... Cleveland.

BULKHEAD DOORS, WATERTIGHT.
"Long Arm" System Co..........Cleveland.

CABIN AND CABINET FINISHING WOODS.
Martin-Barriss Co..................Cleveland.

CANVAS SPECIALTIES.
Baker & Co., H. H..................Buffalo.
Bunker, E. A. ....New York.
Upson-Walton Co..................Cleveland.
Republic Belting & Supply Co......Cleveland.

CAPSTANS.
American Ship Windlass Co..Providence, R. I.
Dake Engine Co............Grand Haven, Mich.
Hyde Windlass Co.................Bath, Me.
Marine Mfg. & Supply Co.........New York.

CEMENT, IRON FOR REPAIRING LEAKS.
Smooth-On Mfg. Co.........Jersey City, N. J.

CHAIN CONVEYORS, HOISTS.
Brown Hoisting Machinery Co. (Inc.)....
.... Cleveland.
General Electric Co........Schenectady, N. Y.

CHAIN HOISTS.
Boston & Lockport Block Co....Boston, Mass.
Republic Belting & Supply Co.....Cleveland, O.

CHARTS.
Penton Publishing Co.............Cleveland.

CLOCKS (Marine and Ship's Bell) AND CHRONOMETERS.
Ritchie, E. S. & Sons........Brookline, Mass.

COAL PRODUCERS AND SHIPPERS.
Hanna, M. A. & Co..............Cleveland.
Pickands, Mather & Co..............Cleveland.
Pittsburg Coal Co.................Cleveland.

COAL AND ORE HANDLING MACHINERY.
Brown Hoisting Machinery Co. (Inc.)....
.... Cleveland.

COMPASSES.
Ritchie, E. S. & Sons........Brookline, Mass.

CONDENSERS.
Great Lakes Engineering Works......Detroit.
Thropp & Sons Co., John E...Trenton, N. J.

CONTRACTORS FOR PUBLIC WORKS.
Breymann & Bros., G. H.............Toledo.
Buffalo Dredging Co.................Buffalo.
Dunbar & Sullivan Dredging Co.....Buffalo.
Great Lakes Dredge & Dock Co.....Chicago.
Hickler Bros.......Sault Ste. Marie, Mich.
Hubbell Co., H. W................Saginaw, Mich
Lake Superior Contracting & Dredging Co.,
.... Duluth, Minn.
Smith Co., L. P. & J. A............Cleveland.
Starke Dredge & Dock Co., C. H..Milwaukee.
Standard Contracting Co..............Cleveland.
Sullivan, M.........................Detroit.

CORDAGE.
Baker & Co., H. H.................Buffalo.
Upson-Walton Co..................Cleveland.

CORK JACKETS AND RINGS.
Armstrong Cork Co............Pittsburg, Pa.
Kahnweiler's Sons, D..............New York.

CRANES, TRAVELING.
Brown Hoisting Machinery Co......Cleveland.

DIVING APPARATUS.
Morse, A. J. & Son..................Boston.
Schrader's Son, Inc., A........ ... New York.

DREDGING CONTRACTORS.
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Buffalo Dredging Co................Buffalo.
Dunbar & Sullivan Dredging Co......Buffalo.
Fitz-Simons & Connell Co...........Chicago.
Great Lakes Dredge & Dock Co.....Chicago.
Hickler Bros..........Sault Ste. Marie, Mich.
Hubbell Co., H. W................Saginaw, Mich
Lake Superior Contracting & Dredging Co.
.... Duluth, Minn.
Smith Co., L. P. & J. A...........Cleveland.
Starke Dredge & Dock Co., C. H..Milwaukee.
Sullivan, M.........................Detroit.

DREDGING MACHINERY.
Quintard Iron Works Co...........New York.

DRY DOCKS.
American Ship Building Co........Cleveland.
Atlantic Works...........East Boston, Mass.
Buffalo Dry Dock Co.................Buffalo.
Chicago Ship Building Co............Chicago.
Craig Ship Building Co...........Toledo, O.
Cramp, Wm. & Sons............Philadelphia.
Detroit Ship Building Co.............Detroit.
Great Lakes Engineering Works......Detroit.
Lockwood Mfg. Co.......East Boston, Mass.
Milwaukee Dry Dock Co..........Milwaukee.
Newport News Ship Building Co.........
.....................Newport News, Va.
Shipowners Dry Dock Co............Chicago.
Superior Ship Building Co....Superior, Wis.
Tietjen & Lang Dry Dock Co.....Hoboken, N.J.

DREDGE BUILDERS.
Manitowoc Dry Dock Co........Manitowoc, Wis.

DYNAMOS.
General Electric Co...........Schenectady, N. Y
Mietz, Aug............................New York.
Thropp & Sons, John E............Trenton, N. J.

ELECTRIC HOISTS AND CRANES.
General Electric Co........Schenectady, N. Y.

WANTED and FOR SALE Department.

PROPOSALS.

U. S. Engineer Office, Duluth, Minn., April 2, 1906. Sealed proposals for building a steel tug complete, will be received here until noon May 2, 1906, and then publicly opened. Information on application. CHAS. L. POTTER, Major, Engrs.

WANTED

Steamboat Wanted.

Capacity about 350 passengers. Length about 100 feet, beam not less than 20 feet. Will buy, charter or exchange. State full particulars.

H. E. SAMPSON,
Owen Sound.

FOR SALE.

For Sale.

Five Scotch Boilers, allowed 160 lbs. steam. Good as new. ERIE MACHINERY CO., 729 Garfield Bldg., Cleveland, O.

A Bargain.

Steamer "Huntress," built in 1880, tonnage 114, length 110 ft., beam 18 ft., draft 7½ ft., carries 215 passengers. Hull and boiler in good condition. For sale at a bargain. Apply for information to SMITH, DAVIS & CO., 200 Main St., Buffalo, N. Y.

FOR SALE.

Lumber Barge.

For sale cheap, Lumber Barge; capacity five hundred and eighty thousand. For full particulars inquire Box 96, MARINE REVIEW, Cleveland, O.

FOR SALE.

Delivery Boat "I-No-U."

We want to sell our delivery boat because we have no further use for her.

She commenced service a new boat in the Spring of 1904. We built her by the day and of the best material we could buy. Cost $2,000. Hull 38½ ft. long, 8½ ft. beam. Frames 2" x 3" at bottom and 2" x 2" at top and spaced 12" from center to center.

For a distance of eight feet alongside of engine there is an intermediate frame. Keel is 5¼" x 10½". Planking and ceiling 1⅛" thick. All White Oak. Engine, 15 H. P. Lacy Single Cylinder Four Cycle. Turns a 34" wheel 300 R. P. M. Speed 8½ miles per hour. Send for photo. We think she is the best built Delivery Boat on the lakes and believe you would be of the same opinion if you saw her. If you need a delivery boat buy a good one and avoid spending a lot of money every winter in repairs, etc.

Address

THE HARDY & DISCHINGER CO.,
Oils & Supplies,
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FOR SALE.

Engine

FOR SALE: Vertical beam jet condensing engine; cylinder 40 inches, 8-foot stroke; built by Fletcher & Harrison; Stevenson front. Engine complete in every particular and in excellent condition. For further particulars apply to HOWARD S. FOLGER, Kingston, Ont., Canada.

A Bargain.

Steamer E. F. Gould, length 137 ft., width 28 ft, depth 8 ft. 5 in, tonnage 261 tons. Boiler, engine and hull in good condition. First-class, complete sand pumping outfit now installed on boat, will sell with boat if so desired. Apply

JOHN M. McKERCHEY,
Detroit, Mich.

Buyers' Directory of the Marine Trade.—*Continued.*

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Mietz, Aug. ....New York.
Thropp & Sons, John E.......Trenton, N. J.

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American Ship Building Co........Cleveland.
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Cramp, Wm. & Sons.............Philadelphia.
Detroit Ship Building Co.............Detroit.
Fletcher, W. & A. Co.........Hoboken, N. J.
Fore River Shipbuilding Co....Quincy, Mass.
Great Lakes Engineering Works.Detroit, Mich.
Hall Bros. ....Philadelphia.
Lockwood Mfg. Co..........East Boston, Mass.
Maryland Steel Co.......Sparrows Point, Md.
Mietz, Aug.......................New York.
Milwaukee Dry Dock Co..........Milwaukee.
Mosher, Chas. D.................New York.
Newport News Ship Building Co.........
......................Newport News, Va.
New York Shipbuilding Co....Camden, N. J.
Northwestern Steam Boiler & Mfg. Co...
.... Duluth, Mich.
Quintard Iron Works Co...........New York.
Roach's Ship Yard...............Chester, Pa.
Sheriffs Mfg. Co.................Milwaukee.
Superior Ship Building Co....Superior, Wis.
Thropp, J. E. & Sons Co......Trenton, N. J.
Trout, H. G.........................Buffalo.

ENGINE ROOM TELEGRAPH, CALL BELLS, ETC.
Cory, Chas. & Son.................New York.
Marine Mfg. Supply Co............New York.

ENGINEERING SPECIALTIES AND SUPPLIES.
Lunkenheimer Co. ....Cincinnati.
Northwestern Steam Boiler & Mfg. Co...
.... Duluth, Minn.

ENGINEERS, MARINE, MECHANICAL, CONSULTING.
Hynd, Alexander ....Cleveland.
Hunt, Robt. W. & Co................Chicago.
Kidd, Joseph..................Duluth, Minn.
Mosher, Chas. D..................New York.
Nacey, James ....Cleveland.
Roelker, H. B. ....New York.
Wood, W. J. ....Chicago.

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Greacen-Derby Engineering Co.............
........................Perth Amboy, N. J.
Ross Valve Co..................Troy, N. Y.

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General Electric Co.......Schenectady, N. Y.

FORGES.
Sutton Co., C. E..................Toledo, O.

FORGINGS FOR CRANK, PROPELLER OR THRUST SHAFTS, ETC.
Cleveland City Forge & Iron Co...Cleveland.
Fore River Shipbuilding Co.....Quincy, Mass.
Macbeth Iron Co..................Cleveland.

FLUE WELDING.
Fix's, S. Sons.....................Cleveland.

FUELING COMPANIES AND COAL DEALERS.
Hanna, M. A. & Co...............Cleveland.
Ironville Dock & Coal Co..........Toledo, O.
Parker Bros. Co., Ltd..............Detroit.
Pickands, Mather & Co............Cleveland.
Pittsburg Coal Co..................Cleveland.
Smith, Stanley B., & Co............Detroit.

FURNACES FOR BOILERS.
Continental Iron Works..........New York.

GAS BUOYS.
Safety Car Heating & Lighting Co..New York.

GAS AND GASOLINE ENGINES.
Chase Machine Co................Cleveland.

GAUGES, STEAM AND VACUUM.
Lunkenheimer Co. ....Cincinnati.

GAUGES, WATER.
Lunkenheimer Co. ....Cincinnati, O.

GENERATING SETS.
General Electric Co...........Schenectady, N. Y.

GRAPHITE.
Dixon Crucible Co., Joseph..Jersey City, N. J

GREASE EXTRACTORS.
Greacen-Derby Engineering Co.............
........................Perth Amboy, N. J.

HAMMERS, STEAM.
Chase Machine Co.................Cleveland.

HEATING APPARATUS.
Sutton Co., C. E..................Toledo, O.

HOISTS FOR CARGO, ETC.
American Ship Building Co........Cleveland.
Brown Hoisting Machinery Co. (Inc.)....
.... Cleveland.
Chase Machine Co................Cleveland.
Dake Engine Co........... Grand Haven, Mich.
General Electric Co...............New York.
Georgian Bay Engineering Works........
..........................Midland, Ont.
Hyde Windlass Co.................Bath, Me.
Marine Iron Co....................Bay City.
Mietz, Aug. ....New York.

HOLLOW SHAFTINGS, IRON OR STEEL.
Falls Hollow Staybolt Co...Cuyahoga Falls, O.

HOLLOW STAYBOLT IRON.
Falls Hollow Staybolt Co...Cuyahoga Falls, O.

HYDRAULIC DREDGES.
Great Lakes Engineering Works......Detroit.

HYDRAULIC TOOLS.
Watson-Stillman Co., The.........New York.

ICE MACHINERY.
Great Lakes Engineering Works......Detroit.
Roelker, H. B...................New York.

INJECTORS.
American Injector Co................Detroit.
Jenkins Bros. ....New York.
Lunkenheimer Co.................Cincinnati.
Penberthy Injector Co.........Detroit, Mich.

INSURANCE, MARINE.
Elphicke, C. W. & Co..............Chicago.
Fleming & Co., E. J.................Chicago.
Gilchrist & Co., C. P.............Cleveland.
Hawgood & Co., W. A............Cleveland.
Helm & Co., D. T...................Duluth.
Hutchinson & Co..................Cleveland.
McCarthy, T. R...................Montreal.
McCurdy, Geo. L...................Chicago.
Mitchell & Co....................Cleveland.
Parker Bros. Co., Ltd..............Detroit.
Peck, Chas. E. & W. F..New York & Chicago.
Prindiville & Co....................Chicago.
Richardson, W. C................Cleveland.
Sullivan, D. & Co..................Chicago.

IRON CASTINGS.
Sutton Co., C. E..................Toledo, O.

IRON ORE AND PIG IRON.
Bourne-Fuller Co..............Cleveland, O.
Hanna, M. A. & Co...............Cleveland.
Pickands, Mather & Co............Cleveland.

LAUNCHES—STEAM, NAPHTHA, ELECTRIC.
Truscott Boat Mfg. Co.....St. Joseph, Mich.

LIFE PRESERVERS, LIFE BOATS, BUOYS.
Armstrong, Cork Co...............Pittsburg.
Drein, Thos. & Son.........Wilmington, Del.
Kahnweiler's Sons, D..............New York.

LIGHTS, SIDE AND SIGNAL.
Russell & Watson ....Buffalo.

LOGS.
Nicholson Ship Log Co............Cleveland.
Walker & Sons, Thomas....Birmingham, Eng.
Also Ship Chandlers.

LUBRICATING GRAPHITE.
Dixon Crucible Co., Joseph..Jersey City, N. J.

LUBRICATORS.
Lunkenheimer Co. ....Cincinnati

LUMBER.
Martin-Barriss Co..................Cleveland.

MACHINISTS.
Chase Machine Co..................Cleveland.
Hickler Bros.........Sault Ste. Marie, Mich.
Lockwood Mfg. Co........East Boston, Mass.

MACHINE TOOLS (WOOD WORKING).
Atlantic Works, Inc.............Philadelphia.

MARINE RAILWAYS.
Hickler Bros..........Sault Ste. Marie, Mich.

MARINE RAILWAYS, BUILDERS OF.
Crandall & Son, H. I.....East Boston, Mass.

MATTRESSES, CUSHIONS, BEDDING.
Fogg, M. W.....................New York.

MECHANICAL DRAFT FOR BOILERS.
American Ship Building Co.......Cleveland.
Detroit Ship Building Co.............Detroit.
Great Lakes Engineering Works......Detroit.

METALLIC PACKING.
Katzenstein, L. & Co.............New York.
The National Metallic Packing Co....Oberlin, O

MOTORS, GENERATORS—ELECTRIC
General Electric Co.......Schenectady, N. Y.

NAUTICAL INSTRUMENTS.
Benjamin Farnum How..................Boston
Ritchie, E. S., & Sons......Brookline, Mass.

NAVAL ARCHITECTS.
Hynd, Alexander ....Cleveland.
Kidd, Joseph ....Duluth, Minn.
Mosher, Chas. D.................New York.
Nacey, James ....Cleveland.
Wood, W. J. ....Chicago.

OAKUM.
Stratford, Oakum Co.......Jersey City, N. J.

OIL ENGINES.
Mietz, Aug. ....New York.

OILS AND LUBRICANTS.
Dixon Crucible Co., Joseph..Jersey City, N. J.
Standard Oil Co...................Cleveland.

PACKING.
Jenkins Bros. ....New York.
Katzenstein, L. & Co.............New York.
The National Metallic Packing Co....Oberlin, O.
Republic Belting & Supply Co.....Cleveland, O.

PAINTS.
Baker, Howard H. & Co.............Buffalo.
Upson-Walton Co. ....Cleveland.

PATTERN SHOP MACHINERY.
Atlantic Works, Inc............Philadelphia.

Buyers' Directory of the Marine Trade.—*Continued.*

PILE DRIVING AND SUBMARINE WORK.

Buffalo Dredging Co................Buffalo.
Dunbar & Sullivan Dredging Co.....Buffalo.
Fitz-Simons & Connell Co............Chicago.
Great Lakes Dredge & Dock Co.....Chicago.
Hickler Bros.........Sault Ste. Marie, Mich.
Hubbell Co., H. W................Saginaw, Mich.
Lake Superior Contracting & Dredging Co. ....Duluth, Minn.
Parker Bros. Co., Ltd..................Detroit.
Smith Co., L. P. & J. A...............Cleveland.
Starke Dredge & Dock Co., C. H..Milwaukee.
Sullivan, M........................... Detroit

PIPE, WROUGHT IRON.

Bourne-Fuller Co..............Cleveland, O.
Macbeth Iron Co.......................Cleveland.
Reading Iron Co...............Reading, Pa.

PLANING MILL MACHINERY.

Atlantic Works, Inc............Philadelphia.

PLATES—SHIP, STRUCTURAL, ETC.

Bourne-Fuller Co..............Cleveland, O.
Otis Steel Co.......................Cleveland.

PRESSURE REGULATORS.

Ross Valve Co...................Troy, N. Y.

PROPELLER WHEELS.

American Ship Building Co........Cleveland.
Atlantic Works...........East Boston, Mass.
Cramp, Wm. & Sons............Philadelphia.
Detroit Ship Building Co...............Detroit.
Fore River Shipbuilding Co.....Quincy, Mass.
Great Lakes Engineering Works.......Detroit.
Hyde Windlass Co.................Bath, Me.
Lockwood Mfg. Co. ....East Boston, Mass.
Milwaukee Dry Dock Co.........Milwaukee.
Newport News Ship Building Co......... ....Newport News, Va.
Roelker, H. B......................New York.
Sheriffs Mfg. Co..................Milwaukee.
Superior Ship Building Co....Superior, Wis.
Thropp & Sons Co., J. E.....Trenton, N. J.
Trout, H. G..........................Buffalo.

PROJECTORS, ELECTRIC.

General Electric Co.......Schenectady, N. Y.

PUMPS FOR VARIOUS PURPOSES.

Great Lakes Engineering Works......Detroit.
Marine Iron Works.................Chicago.
Kingsford Foundry & Machine Works.... ....Oswego, N. Y.

PUNCHES AND SHEARS.

Sutton Co., C. E..................Toledo, O.

RANGES.

Stamford Foundry Co........Stamford, Conn.

REFRIGERATING APPARATUS.

Great Lakes Engineering Works.......Detroit.
Roelker, H. B....................New York.

REGISTER FOR CLASSIFICATION OF VESSELS.

Great Lakes Register.............Cleveland.

RIVETS, STEEL FOR SHIPS AND BOILERS.

Bourne-Fuller Co...............Cleveland, O.

RUBBER SUPPLIES.

Republic Belting & Supply Co.....Cleveland, O.

SAFETY VALVES.

Lunkenheimer Co. ....Cincinnati.

SAIL MAKERS.

Baker, Howard H. & Co.............Buffalo.
Upson-Walton Co...................Cleveland.

SALVAGE COMPANIES.

See Wrecking Companies.

SEARCH LIGHTS.

General Electric Co........Schenectady, N. Y.

SHAFTING, HOLLOW.

Falls Hollow Staybolt Co..Cuyahoga Falls, O.

SHEARS.

See Punches, and Shears.

SHIP AND BOILER PLATES AND SHAPES.

Bourne-Fuller Co..............Cleveland, O.
Otis Steel Co......................Cleveland.

SHIP BUILDERS.

American Ship Building Co........Cleveland.
Atlantic Works ....East Boston, Mass.
Buffalo Dry Dock Co.................Buffalo.
Cramp, Wm. & Sons............Philadelphia.
Chicago Ship Building Co............Chicago.
Detroit Ship Building Co................Detroit.
Fore River Shipbuilding Co.....Quincy, Mass.
Great Lakes Engineering Works......Detroit.
Lockwood Mfg. Co.........East Boston, Mass.
Manitowoc Dry Dock Co.........Manitowoc, Wis.
Maryland Steel Co.......Sparrows Point, Md.
Milwaukee Dry Dock Co...........Milwaukee.
Newport News Ship Building Co......... ....Newport News, Va.
New York Shipbuilding Co....Camden, N. J.
Roach's Ship Yard..............Chester, Pa.
Shipowner's Dry Dock Co...........Chicago.

SHIP CHANDLERS.

Baker, Howard H. & Co............Buffalo.
Marine Mfg. & Supply Co..........New York.
Upson-Walton Co....................Cleveland.

SHIP DESIGNERS.

Kidd, Joseph ....Duluth.
Steel, Nacey & Hynd.............Cleveland.
Wood, W. J.........................Chicago.

SHIP LANTERNS AND LAMPS.

Russell & Watson....................Buffalo.

SHIP TIMBER.

Martin-Barriss Co...................Cleveland.

SMOOTH-ON COMPOUND, FOR REPAIRS.

Smooth-On Mfg. Co.......Jersey City, N. J.

STAYBOLT IRON OR STEEL BARS, HOLLOW OR SOLID.

Falls Hollow Staybolt Co..Cuyahoga Falls, O.

STEAM VESSELS FOR SALE.

Holmes, Samuel ....New York.
Lester, S. S....................Quebec, Can.
McCarthy, T. R...............Montreal, Can.

STEAMSHIP LINES, PASS. AND FREIGHT.

American Line ....New York.
Anchor Line ....Buffalo.
Boston Steamship Co...................Boston.
Cleveland & Buffalo Transit Co.....Cleveland.
International Mercantile Marine Co...... ....Philadelphia.
Mallory Line ....New York.
Merchants' Montreal Line..........Montreal.
New York & Cuba Mail S. S. Co...New York.
Red Star Line....................New York.
United Fruit Co......................Boston

STEEL CASTINGS.

Otis Steel Co.........................Cleveland.
Sutton Co., C. E...................Toledo, O.

STEERING APPARATUS.

American Ship Building Co.........Cleveland.
Chase Machine Co...................Cleveland.
Dake Engine Co.............Grand Haven, Mich.
Detroit Ship Building Co.............Detroit.
Hyde Windlass Co..................Bath, Me.
Marine Mfg. & Supply Co.........New York.
Moulton Steering Engine Co.......New York.
Sheriffs Mfg. Co....................Milwaukee.

SUBMARINE DIVING APPARATUS.

Morse & Son, A. J...................Boston.
Schrader's Son, Inc., A...... ....New York.

SURVEYORS, MARINE.

Gaskin, Edward ....Buffalo.
Hynd, Alexander ....Cleveland.
Parker Bros. Co., Ltd...............Detroit.
Nacey, James ....Cleveland.
Steel, Adam ....Cleveland.
Wood, W. J.........................Chicago.

TESTS OF MATERIALS.

Hunt, Robert W. & Co..............Chicago.
Lunkenheimer Co.............Cincinnati, O.

TOOLS, METAL WORKING, FOR SHIP AND ENGINE WORKS.

Watson-Stillman Co...............New York.

TOOLS, WOOD WORKING.

Atlantic Works, Inc............Philadelphia

TOWING MACHINES.

American Ship Windlass Co..Providence, R. I.
Chase Machine Co...................Cleveland.

TOWING COMPANIES.

Donnelly Salvage & Wrecking Co........ ....Kingston, Ont.
Great Lakes Towing Co...........Cleveland.

TRUCKS.

Boston & Lockport Block Co.........Boston.

TUBING, SEAMLESS.

Shelby Steel Tube Co.........Pittsburg, Pa.

VALVES, STEAM SPECIALTIES, ETC.

Jenkins Bros. ....New York.
Lunkenheimer Co..................Cincinnati.
Ross Valve Co...................Troy, N. Y.

VALVES FOR WATER AND GAS.

Lunkenheimer Co..................Cincinnati.
Republic Belting & Supply Co.....Cleveland, O.
Ross Valve Co...................Troy, N. Y.

VARNISHES.

Detroit Varnish Co...................Detroit.
Detroit White Lead Works..........Detroit.
Also Ship Chandlers.

VENTILATING APPARATUS FOR SHIPS.

Sutton Co., C. E..................Toledo, O.

VESSEL AND FREIGHT AGENTS.

Boland, John J.........................Buffalo.
Brown & Co...........................Buffalo.
Elphicke, C. W. & Co..............Chicago.
Fleming & Co., E. J..................Chicago.
Hall, John B..........................Buffalo.
Helm & Co., D. T...................Duluth.
Hawgood & Co., W. A.............Cleveland.
Holmes, Samuel ....New York.
Hutchinson & Co...................Cleveland.
Lester, S. S. ....Quebec, Can.
McCarthy, T. R.....................Montreal.
Mitchell & Co.......................Cleveland.
Parker Bros. Co., Ltd................Detroit.
Prindiville & Co......................Chicago.
Richardson, W. C...................Cleveland.
Sullivan, D. & Co....................Chicago.

WATER GAUGES.

Lunkenheimer Co.............Cincinnati, O.

WATERTIGHT BULKHEAD DOORS.

"Long Arm" System Co..........Cleveland.

WHISTLES, STEAM.

Lunkenheimer Co................. Cincinnati

WILFORD'S WATERPROOF CLOTH.

Bunker, E. A. ....New York.

WIRE ROPE AND WIRE ROPE FITTINGS.

Baker, H. H. & Co..................Buffalo.
Upson-Walton Co...................Cleveland.

WINDLASSES.

American Ship Windlass Co..Providence, R. I.
American Ship Building Co.......Cleveland.
Dake Engine Co............ Grand Haven, Mich.
Hyde Windlass Co.................Bath, Me.
Marine Mfg. & Supply Co........New York.

WINCHES.

American Ship Windlass Co..Providence, R. I.
Georgian Bay Engineering Works........ ....Midland, Ont.
Hyde Windlass Co.................Bath, Me.

WOOD WORKING MACHINERY.

Atlantic Works, Inc............Philadelphia.

WRECKING AND SALVAGE COMPANIES.

Donnelly Salvage & Wrecking Co........ ....Kingston, Ont.
Great Lakes Towing Co............Cleveland.
Parker Bros. Co., Ltd...............Detroit.

YACHT AND BOAT BUILDERS.

Drein, Thos. & Son........Wilmington, Del.
Manitowoc Dry Dock Co........Manitowoc, Wis.
Truscott Boat Mfg. Co.....St. Joseph, Mich.

YAWLS.

Drein, Thos. & Son........Wilmington, Del.